भाकृअनुप
ICAR

SIXTH
DEANS' COMMITTEE
REPORT

AGRICULTURAL EDUCATION DIVISION
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-II
Pusa, New Delhi-110012

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सत्यमेव जयते
डॉ. हिमांशु पाठक
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Dr HIMANSHU PATHAK
SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)

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Foreword

The Indian Council of Agricultural Research (ICAR) has played the vital role in transforming the agricultural higher education to produce highly skilled human resource equipped with advance knowledge and capable of fulfilling the agricultural needs of the country. National Education Policy (NEP-2020) of India represents a comprehensive and ambitious vision for the future of education in the country. There is an urgent need to revise and align the agricultural education system in the country in line with NEP-2020 norms to build a competent human resource for undertaking education, research and extension activities at diversified, ecologically sustainable and economically viable agricultural and allied sectors with integration of technology and innovation.

The Indian Council of Agricultural Research (ICAR) has been at the forefront of promoting excellence in agricultural education, focusing on the development of a skilled workforce to meet the nation's growing agricultural demands. To ensure that agricultural education stays relevant, the ICAR has regularly revised curricula through various Deans' Committees, with five such committees already having updated the academic standards over the years. These revisions align the education system with both national and international standards ensuring students are prepared for the challenges of modern agriculture.

The Sixth Deans' Committee, constituted in the year 2021, has prudently with congruence of excellence and relevance revised the undergraduate course curriculum, course contents, degree nomenclature including entry-exit options recommending the reforms in admission including lateral entry options and examinations. The committee had updated the course curriculum as per the guidelines of NEP-2020 focussing skill enhancement with integration of digital learning to align with the evolving global requirements and the advent of new technologies with focus on better employability, flexibility in movement from one institution to another, multiple entry and exit options, choice-based credit system. Experiential leaning and entrepreneurship development programs have been included for training student in real work satiations to develop them as future entrepreneurs. Academic Bank of Credits (ABC) introduced to facilitate

movement from one institution to another with credit transfer. Innovative teaching approaches such as online, open distance learning (ODL) and blended learning have been emphasized to merge traditional and non-traditional educational methods. The continuous updating of course curricula based on recent technological advancements ensures that students remain at the cutting edge of agricultural knowledge.

The Council expresses gratitude to Dr. Tej Partap, Chairman of the Sixth Deans' Committee, for his leadership,as well as to the committee members for their efforts in aligning agricultural education with NEP-2020 and global trends. I appreciate the efforts of Dr. R. C. Agrawal, Deputy Director General (Education) and all the committee members to align,update and contextualise the academic pursuits with NEP-2020 guidelines and to prepare this valuable report. Dr Ajit Singh Yadav, ADG (EQAR & Member Secretary, Sixth Deans' Committee) has rendered untiring efforts in arranging meetings and facilitating the course of deliberations, drafting and compilation of report.

The ICAR shall strive to implement all the recommendations of the report. I hope it will help to achieve our mission to make agricultural education more accessible, affordable, relevant, practical and professional pursuing national and international quality education standards.

(Himanshu Pathak)

Dated: 10 September, 2024
New Delhi

Overview of 6th Deans Committee Report

Indian Council of Agricultural Research (ICAR) under the Department of Agricultural Research and Education Government of India, is tasked with the responsibility to aid, impart and coordinate agricultural education to develop high-quality human resources in the country. The National Education Policy-2020 (NEP-2020) presents an opportunity for substantial reforms in the education system, including higher agricultural education. Soon after the announcement of the NEP-2020, ICAR formulated a committee and developed the guidelines "Implementation strategy for National Education Policy-2020 in Agricultural Education system" during September, 2021. Accordingly, all the Agricultural Universities (AUs) started implementing various provision of NEP-2020 in their respective AUs. Following the committee's recommendations, the Sixth Deans' Committee was constituted on August 17, 2021 (orders issued on Sep 15, 2021 vide notification *F. No. Edn.5/24/202/EQR/VI Deans)*. The 6th Deans' Committee was mandated to revamp the course curriculum, credit framework, and academic standards for agricultural education. This initiative aims to standardize uniform academic structures across the country both in public and private institutions offering undergraduate (UG) programs in agriculture and allied sciences.

To formulate the guidelines, course curriculum & credit framework, and other aspects series of meetings and consultations (both off line and online) of committee were held and all aspects were discussed in detail taking into consideration of NEP-2020 provisions. The member of the committee consulted the subject specific experts by holding off line and online meeting. A meeting was also organized with CEO, Agriculture Skill council of India on modalities of integration of vocational courses in the general agriculture education course framework. Further, a meeting with Chairman, UGC was also held to discuss the UG course curriculum of all agriculture and allied science disciplines as per the NEP-2020 and UGC guidelines. The general guidelines, course curriculum and credit framework was also presented in Vice-Chancellor' Conference held at NASC, New Delhi and suggestions were incorporated in the report. The report was also presented in a meeting chaired by Secretary DARE & DG ICAR. All Deputy Director General (DDGs) & Assistant Director General (ADGs) of education suggested the changes which were incorporated. The report was also sent to all DDGs for their inputs and suggestions. The draft report was sent all Vice Chancellors of SAUs/CAUs/DUs/CUs with agriculture faculty for taking views/suggestions of faculty and students. In addition, views of foreign experts were also invited on the draft report. The final report on general guidelines, course curriculum, credit framework of all the UG disciplines was prepared in consultation with stakeholders.

Guided by the principles and philosophy of NEP-2020, the committee developed a comprehensive report outlining a restructured course curriculum and credit framework for 13 UG disciplines in agriculture and allied sciences and necessary provisions have been made in the curriculum to enable an individual to study report major and minor courses along with choice of electives. The 13 UG disciplines of which the course curriculum and credit framework was restructured includes Agriculture, Agricultural Engineering, Biotechnology, Dairy

Technology, Fisheries Science, Food Technology, Forestry, Community Science, Horticulture, Food Nutrition and Dietetics, Sericulture with inclusion of two new disciplines namely Natural Farming and Agribusiness Management.

Key features of the report include curriculum revision, modification of academic structure of degrees/diplomas/certificates, the introduction of an academic banking system (ABC), a multiple entry-and-exit system, flexible course selection, introduction of skill enhancement courses, making internship as part of UG-certificate, UG-diploma and degree requirements, and the incorporation of industry-oriented internships as part of UG requirements. A course entitled "*Deeksharambh*" has been introduced in the first semester for a duration of two weeks to acquaint students to learn from each other's life experiences, traditional values and traditional cultures and values. Common courses have been proposed developing better communication skills and personality development as well as to have a broader view of agriculture and allied sectors. New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula for preparing student in the era of Digital Technology. Progressive assessment of the student/s is part of course curriculum and the focus is enhancing their critical thinking and creativity rather than rote reading.

During this comprehensive exercise of restructuring the course curriculum and credit framework, the much-needed support, inputs and participation rendered by Hon'ble Vice-Chancellors of SAUs/CAUs/DUs/ CUs with Agriculture Faculty is greatly acknowledged. The support and help extended by all Deputy Director Generals is much appreciated.

I also take this opportunity to express a deep sense of gratitude to Dr Trilochan Mohapatra, Former Secretary, DARE and Director-General, ICAR for his initiatives, guidance and support. I feel extremely happy to take this opportunity to express my deep sense of gratitude to Dr Himanshu Pathak, Secretary DARE and DG, ICAR for reposing faith in the committee and also constantly providing visionary guidance, cordial support and valuable inputs which helped in completing this task through various stages.

I hope, the educational reforms as suggested by the Sixth Deans Committee shall lead to a complete overhaul, and re-energise the higher agricultural education system to overcome the challenges currently being faced in India and thereby, deliver high quality higher agricultural education with equity and inclusion with focus to make the agricultural graduates as global leaders equipped with skills of better employment.

(R.C.Agrawal)
Deputy Director General (Agricultural Education)

Dated: 10 September, 2024
ICAR, New Delhi

Preface

Enhancing quality of human resource is a pre-requisite for implementing and upgrading research programs, developing technologies, evolving institutional arrangements to face challenges and to harness opportunities in the global perspective. Moreover, in the agriculture and allied sectors, such aspects are still more important due to the rapid changes occurring in challenges as well as in technologies. There is an urgent need of adequate trained manpower, that is professionally competent, socially sensitive and ethically strong to -- provide the technical backstopping in the changing resource constraints scenario in terms of land and water availability, and sustain agricultural growth with challenges of climatic adversities.

The ICAR having the mandate of guiding, managing and coordinating agricultural education in the country has been working in this regard and the National Agricultural Research, Education and Extension (NAREE) system continues to strive for maintaining and upgrading the quality and relevance of higher agricultural education through the partnership with 76 Agricultural Universities (AUs) comprising State Agricultural Universities (SAUs), ICAR Deemed-to-be-Universities (ICAR DUs), Central Agricultural Universities (CAUs) and Central Universities (CUs) with Agriculture faculty. One such measure that Council has taken periodically is the constitution of Deans' Committee for revising the course curriculum and also to undertake reforms in agricultural education in line with national priority.

National Education Policy (NEP-2020) was launched by the Government of India for transforming India's education system, seeking reforms at school, college, and university levels to build a knowledge-driven society. The NEP-2020 clearly indicates the need for reviving agricultural education which must be aligned with NEP-2020 based on its five pillars, namely, Access, Equity, Quality, Affordability, and Accountability. The NEP-2020 calls for improvement in both the capacity and quality of agricultural education with the aim to develop good, thoughtful, well-rounded, and creative individuals. This policy also focuses on the study of one or more specialized areas of interest at a deep level, and also on developing character, ethical and constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first century capabilities across a range of disciplines.

This report is the outcome of the Sixth Deans' committee, which was constituted by the Council to restructure course curricula of the UG programs and to align these with the NEP-2020 adopting a bottom-up approach involving all stakeholders. The Committee considered the academic aspects needed to be incorporated for the transformation of agricultural education system so as to prepare the youth to take up the challenges and opportunities in this vital and vibrant field. The main responsibility of the committee was the articulation of the knowledge and skills needed among the graduates and reform the course curricula for technological integration-based innovations for enhancing their skills, entrepreneurship, employment potentials, thus transforming them from job-seekers to job- providers.

The report is in two parts. The PART-I comprises general recommendations on curriculum and credits as well as other guidelines on admissions, evaluations, etc., that is applicable to all disciplines and institutions involved in imparting higher agricultural education. The PART-II comprises discipline-wise recommended course curricula of undergraduate programs for thirteen ICAR approved disciplines. As per the provisions of NEP-2020, there are options for multiple entry and exit. Provision has been made for exit after the 1st year for award of UG-Certificate and after 2nd year for award of UG-Diploma after completion of internships at each level. Similarly, entry options for UG-Certificate and UG-Diploma holders have been made in 3rd and 5th semesters, respectively. Choice based skill enhancement courses have been integrated in the course programs. The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path through several modes of skill development programs as in-plant training, internship, projects and rural agricultural work experience, etc.

Common courses of multi-disciplinary, value-added, and ability enhancement categories as per NEP-2020 guidelines have been recommended for all the disciplines to enhance the communication skills and development of personality of students and to prepare them for collaboration with other sectors to face the next generation challenges from a holistic point of view. Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the Deeksharambh, NCC, NSS and focus has also been given on health and wellness.

The students will also take online courses, which will be choice based, to groom their passion or strengthen their knowledge and competency in any field beyond the prescribed courses. There are provisions for elective courses, which will also be choice based and the institutions will also have the liberty to develop new elective courses as per local needs and available expertise. As per NEP-2020 guideline, introduction of Academic Bank of Credits (ABC) for the students will be in practice, which can facilitate institutional transfer of students. New age courses like artificial intelligence, robotics, machine learning, nanobiotechnology, renewable energy, information technology etc. have been duly internalized in course curricula.

The committee is grateful to Dr Himanshu Pathak, Secretary DARE and Director General, ICAR; Dr Trilochan Mohapatra, former Secretary DARE & DG, ICAR for reposing faith in the Committee and giving opportunity and providing guidance in restructuring the course contents and also for giving their valuable inputs for updating the curricula as per the need of agriculture and allied sectors to face challenges at global level.

The Committee is highly beholden to Dr R.C. Agrawal, DDG (Agril. Edn.), ICAR for his valued inputs, guidance and constant support. The Committee also puts on record its gratitude to all Deputy Director Generals, ICAR; Vice Chancellors; Deans and other stakeholders for their constant guidance and support, which were critical in shaping this document and completing this important task. The committee also gratefully acknowledges the contributions of Dr Bimlesh Maan, ADG (EP&HS); Dr Seema Jaggi, ADG (HRD); Dr Vanita Jain, Dr Smita Sirohi, Dr K.P. Tripathi, Principal Scientists of Education Division, ICAR. The contribution of Subject Matter Specialists as members and special invitees of the Deans' Committee, is gratefully acknowledged.

We also take this opportunity to thank and acknowledge the contributions of Sixth Deans Committee members, namely, Dr Shanti K. Sharma ADG (HRM) (Natural Framing); Dr Sanjaya K Dash (Agril Engineering); Dr Jayant Deka (Agriculture); Dr R R B Singh (Dairy Technology); Dr R F Sutar (Food Technology); Dr Reeta Raghuvanshi (Food Nutrition and Dietetics); Dr Meenu Shrivastava (Community Science); Dr K T Parthiban (Forestry); Dr M I S Gill (Horticulture); Dr S Chandrasekhar (Sericulture); Dr Ramesh Bhat (Biotechnology); Dr V R Kiresur (ABM) and Dr B K Das (Fisheries Science) for their important role in this strenuous task.

The report is expected to stimulate policy innovations and also institutional reforms in academics paving way in building students for more meaningful and satisfying lives and work roles and enabling economic independence of learners capable of global competence. We are confident the guidelines and curriculum in this report would encourage higher agricultural education institutions to shape new generation youth in agriculture and allied fields and motivate all stakeholders, educationists to policy makers in contributing in fulfilling the aspiration of NEW INDIA.

(Ajit Singh Yadav)
Member Secretary
(6th Deans' Committee)

(Tej Partap)
Chairman
(6th Deans' Committee)

ICAR-SIXTH DEANS' COMMITTEE

Task Accomplishment Certificate

The 6th Deans Committee was set up by ICAR, on the recommendations of the ICAR Expert Committee on Implementation Strategy for executing National Education Policy (NEP-2020) across the 13 disciplines that fall under Agriculture and Allied Disciplines of Agricultural Education system. Under National Education Policy (NEP-2020) regime, ICAR as Professional Standards Setting Body (PSSB) for Agricultural Education in the country, has the primary task of prescribing the course curricula and credit framework that will govern agricultural education in the country. Therefore, as a step towards implementing NEP-2020, ICAR constituted 6th Deans' Committee with a specific mandate of restructuring course curricula and regulations for the degree programs in operation under agricultural education in the country.

The committee members, comprising the Chairman and Deans, representing each academic program, as expert members, held several deliberations and prepared a framework of the restructured academic system, defining credit hours, focus of semesters, integration of skill development opportunities and system of specialization within the degree programs and other provisions of NEP-2020, which will be common to all programs. Thereafter, each Member-Dean, worked with experts within their respective disciplines working across universities/institutions to restructure the course curricula as per NEP-NHEQF, that was considered paramount imperative. Draft notes were circulated among the members and academic experts for their suggestions. Committee also received inputs from ICAR, foreign experts, Vice Chancellors, DDGs and other stakeholders through the office of Deputy Director General-Agricultural Education. Report of the 6th Deans Committee is an outcome of these efforts.

This NEP-NHEQF guided restructuring of Undergraduate Programs of Agricultural Science, is expected to help build strong foundation of both knowledge and skills. More emphasis has been given to Skill training and flexibility in choice of courses to adopt the choice-based credit system. It is our belief that the restructured academic programs will help produce new generation of human resources in agricultural domain/disciplines, which will be equipped to meet the needs of new knowledge and skills in agricultural sector.

The committee members draw satisfaction in accomplishing this task and are grateful to ICAR for reposing trust on them to undertake this onerous task, as well as to office of DDG (Agricultural Education) for coordinating the support services during the process. We thank all those academicians across the agricultural education landscape of the country, who were consulted, who offered new ideas, and those who offered constructive criticism. Down the years, we look forward to see the fruits of this work by way of transformed agricultural education system of the country.

(TEJ PARTAP)
Chairman, Sixth Deans' Committee, ICAR

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1. Sixth Deans' Committee: Terms of Reference

1.1 Constitution of Committee for drafting the Implementation Strategy for Higher Agriculture Education

As a follow up to the National Education Policy-2020 (NEP 2020), ICAR, as Professional Standards Setting Body (PSSB) of agricultural education for the NEP-2020, set up a high-level committee comprising the Vice Chancellors of Agriculture Universities. It was asked to devise a strategy for implementing NEP-2020 in agricultural education. Besides several other recommendations, the high-level committee recommended the constitution of Sixth Deans' Committee for restructuring the course curricula, framed by the Fifth Deans' Committee. Universities have adopted the Fifth Deans Committee for implementation since 2016. The NEP-2020 required that this course curriculum is restructured to fit into the new academic regime.

1.2 Notification for Setting up the Sixth Deans' Committee

On the Recommendations of ICAR-NEP Implementation Strategy Committee, ICAR constituted the Sixth Deans' Committee on August 17, 2021 (orders issued on Sep 15, 2021) vide notification *F. No. Edn.5/24/202/EQR/VI Deans.* The 6th Deans' Committee was mandated to restructure the existing course curricula so as to enable implementation of NEP- 2020 in agricultural education.

1.3 Terms of References of the 6th Deans' Committee

i) Restructuring of all UG Programs, all UG programs to be restructured as per NEP-2020 and NHEQF.

ii) Structure of first year UG Certificate Course, areas, end of course test and criteria for entry into second year Diploma course as per provisions of NEP-2020.

iii) Admission Criteria for UG-Certificate and UG Diploma courses, in view of the multiple entry and exit system provision under NEP-2020.

iv) Guidelines for Entrepreneurship of students.

v) Guidelines on provision for increasing gross enrolment ratio (GER), progressively.

vi) Defining UG and PG degrees for general market needs, as well as for specialist jobs and uniformity in UG and PG degree nomenclature.

vii) Any other point related to NEP-2020.

2. Prologue

2.1 Aim of Restructuring Agricultural Education

Education is at the heart of both personal and community development; its mission is to enable each of us, without exception, to develop all our talents to the full and to realize our creative potential, including responsibility for our own lives and achievement of our personal aim. There is, therefore, every reason to place renewed emphasis on the moral and cultural dimensions, apart from what is taught presently, enabling each person to grasp the individuality of other people and to understand the world's progression towards an uncertain future.

The 21st century is showing all signs of providing unprecedented means for communication and for the circulation and storage of information. Therefore, it will impose on education two demands which at first sight may appear contradictory. Education must transmit, efficiently and on a massive scale, an increasing amount of constantly evolving knowledge and know-how adapted to a knowledge driven civilization, because this forms the basis of the skills of the future. At the same time, it must find and mark the reference points that will make it possible, on the one hand, for people not to be overwhelmed by the flow of information, invading the public and private domains and, on the other hand, to keep the development of individuals and communities as its end in view. Education must, as it were, simultaneously provide maps of a complex world in constant turmoil and the compass that will enable people to find their way in it.

In this view of the future, traditional responses to the demand for education that are essentially quantitatively, and knowledge based are no longer appropriate. It is not enough to supply each student with a store of knowledge to be drawn on from then on. Instead, everyone must be equipped to seize learning opportunities throughout life, both to broaden her or his knowledge, skills, and attitudes, and to adapt to a changing, complex and interdependent world.

2.2 Four Pillars of Education

The International Commission on Education in its report "Learning: The Treasure Within" (UNESCO, 1996) has defined "why and how" agenda for modifying education for 21st century, globally. It advocated inclusion of the concept of following four pillars of education if education is to succeed in

its task. NEP also has advocated similar perspective of future education system in India. Sixth Deans' Committee would like to lay stress on institutions to reorganize their existing academic system of agricultural education around these four fundamental types of learning. In a way these pillars must remain the pillars of knowledge, throughout a person's life.

1. *Learning to know* -- acquiring the instruments of understanding.
2. *Learning to do* -- to be able to act creatively on one's environment.
3. *Learning to live together* -- so as to participate and cooperate in all human activities.
4. *Learning to be* an essential progression which proceeds from the previous three.

These four paths of knowledge, all form a whole with many points of contact, intersection, and exchange among them.

2.3 Constitution of the report

The report is in two parts. PART-I comprises General Report on curriculum and credits as well as other general guidelines on admissions, evaluations, etc., that is applicable to all disciplines, colleges, universities, institutions, who are involved in imparting higher agricultural education in any of the following ways in the country.

PART-II of the report comprises discipline-wise recommendations, on restructured course curricula of undergraduate degree programs, for 13 ICAR approved disciplines, as follows.

1. Agriculture
2. Agricultural Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries Science
6. Food Technology
7. Forestry
8. Community Science
9. Horticulture
10. Food Nutrition and Dietetics
11. Sericulture
12. Agribusiness Management
13. Natural Farming

3. Executive Summary

New Education Policy-2020 (NEP-2020) of India proposed many changes in the education system of India, including higher agriculture education system. A national level Committee was constituted by ICAR to develop an implementation strategy to comply with various provisions of National Education Policy (NEP-2020). ICAR constituted the Sixth Deans' Committee to restructure the existing course curricula so as to enable implementation of NEP-2020 in agricultural education. As per the NEP-2020 recommendations, the Sixth Deans' Committee has incorporated following several new initiatives in the proposed restructured UG curricula.

3.1 Classification of level of courses with targeted outcomes

The courses have been classified as per the level of teaching and also based on targeted outcome.

- The 1st year of the UG programme (NHEQF Level 4. 5) includes the Foundation courses, introductory courses and skills enhancement courses/training in the chosen area, ability enhancement courses. It is aimed that student/s will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment/ entrepreneurship.
- The 2nd year (NHEQF Level 5) includes the basic core courses and additional skill enhancement in chosen areas/ courses. It is aimed that the student/s will acquire the higher level knowledge in respective disciplines and adequate skills in some selected areas, to enable them employment at middle level/ supervisory level or for entrepreneurship.
- The 3rd year includes the advanced core subjects and their practical applications with an objective that the student will have deeper understanding of the subjects and their major application areas.
- The 4th year (NHEQF Level 6) will have the specialization/ elective courses and advanced skill enhancement through project and internship. The student will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than a job seeker through establishment of enterprises in concerned fields.

3.2 Multiple Entry and Exit

There is provision of multiple entry and exit at different levels. The student/s will have the option to exit after the 1st year. He/ she/ ze has to complete 10 weeks of internship (10 credits) after 1st year (2 semesters) to be eligible for award of UG-Certificate. The student has another option to exit after the 2nd year. The student has to complete another 10 weeks of internship (10 credits) after 2nd year (4 semesters) to be eligible for award of UG-Diploma.

After four years of study, the student will be awarded UG degree in concerned discipline. No exit after 3 years (6 semesters) is recommended considering the professional nature of the courses.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in recognised HAEIs. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

3.3 New courses for acquiring advanced knowledge and skill and for strengthening their cultural and ethical values and through choice based programs

3.3.1 Deeksharambh (Induction—cum-foundation course)

A course entitled "*Deeksharambh*" (0+2) (Non-gradial) will be offered at the start of first semester for a duration of two weeks. This will create a platform for students to learn from each other's life experiences, help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instilling life and social skills, social awareness, ethics and values, team work, leadership, creativity, etc. It will also help in identifying the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario. There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic and research managers.

3.3.2 Common courses

The following common courses have been proposed to be offered across the disciplines. This will enable the student for better communication skills and personality development as well as to have a broader view of agriculture and allied sectors, which will allow them for future collaboration with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade
- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics and Artificial Intelligence

In addition to these common courses and *Deekshyarambh*, the courses such as Physical Education, First Aid, Yoga Practices, Meditation, NCC and NSS have also been made compulsory for students for better social awareness and health of the future generation.

3.3.3 New age courses

New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. Besides an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his/her/ze interest. Due emphasis has been given to include the latest topics and subjects in both core and elective courses. Practical exercises and teaching methodology are proposed to make the young generation more imaginative, innovative, ingenious, creative and competent.

3.3.4 Online courses

The students will have to take a minimum of 10 credits of online courses, comprising one or more courses, as a partial requirement for the UG programme. The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from any online portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

3.3.5 Elective courses

The institutions will offer a bouquet of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report. The institutions will also have the liberty to develop new Elective courses as per local needs and available expertise.

3.4 Imparting Traditional Knowledge, Values and Ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the *Deeksharambh*, NCC/ NSS. It is proposed that Study tours shall be conducted across the country to make the student aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

3.5 Entrepreneurship development as a career path

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP- 2020, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

Skill enhancement courses are included in different modes as follows:

- Skill enhancement courses in the 1st year and 2nd year as part of the course programs;
- Internship for exit programs after 1st year/ 2nd year; and
- Advanced skill enhancement through Student READY programs such as in-plant training/ internship/ projects in 4th year.

The skills acquired must make the students proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field. It will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

3.5.1 Skill Enhancement Courses

Skill enhancement courses are essential requirements for any programme (UG-Certificate/ UG-Diploma or Degree). These will be choice based; student can choose the areas of skill enhancement from a bouquet of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs/ farmers for running various skill enhancement programs.

The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources. In addition, the skill enhancement courses suggested by the UGC, may also be offered.

3.5.2 Internship

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after 2nd year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/ research institution/ project or with a progressive farmer/ agri enterprise, etc.

3.5.3 Projects

For some disciplines, Projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications. They will be able to choose appropriate career in research or employment/ entrepreneurship, discover their interests, aptitudes and potentialities and maximise their potentialities and self-confidence. It will also add to creativity and critical thinking of the students.

3.6 Introduction of new degree programs

Two new degree programs have been proposed in this report in two important areas.

1. Considering the natural strength of the country and future opportunities, a new UG course on Natural farming has been included. The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farmland ecosystem, and reducing the market inputs. These important aspects of natural farming are considered as cost-effective and suitable for livelihood of large number of farmers and sustainable rural development.
2. A new degree programme on Agribusiness Management has been included. These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.

3.7 Light but tight educational programme

As per the norms of the NEP-2020, the programme has been made light but tight for the students. The total credit hours have been kept at 166 considering the specific need of the professional courses, however, in some of the disciplines, viz. Agril Engineering, Food Technology and Dairy Technology, the total credit hours ranged from 172 to 174. At the same time, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning experience more pleasurable and learning efficient.

3.8 Progressive evaluation

In the course programme, 20% has been kept for progressive assessment of the student within the semester in form of quizzes/ group assignments. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in the form of group assignments (which should encourage creativity, critical thinking and problem- solving attitude).

3.9 Academic Bank of Credit

As per NEP-2020 guidelines, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/ NEP-2020 recommendations.

3.10 Migration of students from one institution to other

It has been proposed for inter-institutional transfer of students with accumulation of the ABC. The University/ HAEI may admit students either by holding its own admission test or use merit as criteria or by following any of the existing norms of both transferring and accepting Universities/HAEIs. The migration shall be subject to availability of seats at the accepting HAEI. It is recommended to make institutional migration after 4th semester. HAEIs are at liberty to put in place rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students.

3.11 Minimum requirement for establishing colleges for agriculture and allied disciplines

The minimum requirements for establishing colleges for 13 agriculture and allied sciences disciplines shall be as per the ICAR Model Act-2023 and various guidelines and orders being issued by ICAR from time to time.

3.12 Making implementation of the recommendations of the Deans' Committee mandatory

Efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programs and academic institutions by the National Agricultural Education Accreditation Board (NAEAB) of ICAR.

4. Restructuring of Undergraduate Programmes

4.1 Restructuring of UG Programs

The restructuring has been done based on the following NHEQF levels:

- Year 1, Certificate Course, NEP-NHEQF Level 4.5
- Year-2, Diploma Course, NEP-NHEQF Level 5.0
- Year 4, B.Sc. (Hons.)/ B. F. Sc. (Hons.)/ B. Tech. NEP-NHEQF Level 6.0

The restructured program for the undergraduate agriculture education with multiple entry and exit options is illustrated in Figure 4.1.

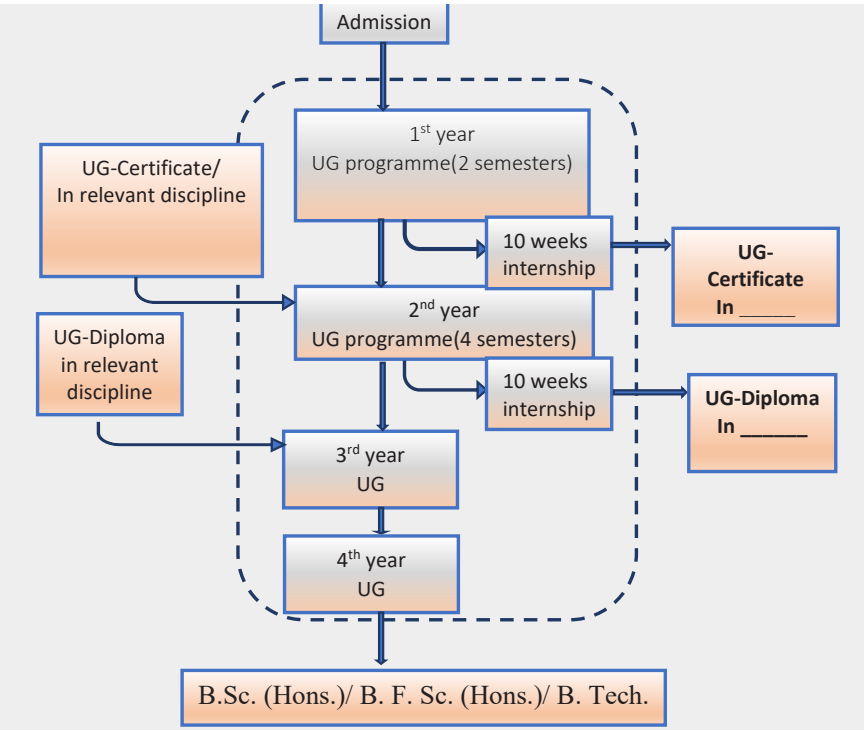

Fig. 4.1 Framework of Undergraduate Programmes

The eligibility for entry into the UG programs will be + 2 Science; the students will be admitted as per norms of ICAR/ SAUs/CAUs. The 1st year of the programme will be having the foundation, introductory and skill enhancement courses. The 2nd year will be having basic core courses with

some more options for skill enhancement. The 3rd year of the programme will have advanced core courses. The 4th year programme will emphasize more on the specialisation and elective courses as well as advanced skill enhancement through internship.

There will be exit options after 1st year and 2nd year for UG-Certificate and UG-Diploma. However, the students opting to exit with UG-Certificate or UG-Diploma will have to take up 10 weeks internship after the 1st year (2 semester) and 2nd year (4 semesters), respectively.

Table 4.1 shows the restructured undergraduate programs for the higher agricultural educational institutions (HAEIs).

Table 4.1 Types of courses and learning outcomes for the restructured undergraduate programs for the HAEIs

Year	Types of courses	Learning outcome	Exit option
YEAR 1 NHEQF Level 4.5	Foundation courses, introductory courses and skills enhancement training/ training in the chosen area, ability enhancement courses	Students will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment/ entrepreneurship	A student must complete 10 weeks of internship (10 credits) after 1st year if exit with UG-Certificate is opted
YEAR-2 NHEQF Level 5	Basic core courses and additional skill enhancement in chosen areas/ courses	Students will acquire the higher level knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment at middle level/ supervisory level or for entrepreneurship	A student must complete 10 weeks of internship (10 credits) after 2nd year if exit with UG-Diploma is opted
YEAR-3	Advanced core subjects and their practical applications	Students will have deeper understanding of the subjects and their major application areas	No exit after 3rd year
YEAR-4 NHEQF Level 6	Specialization/ Elective courses and advanced skill enhancement through project and internship	Students will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than being a job seeker through establishment of enterprises in concerned fields.	UG degree in concerned discipline

4.2 Credit Hours Allocation

A total of 166-174 credit hours is recommended for the four years of UG programs. The credit distributions for the different courses have been specified for individual disciplines. The general structure is given in Table 4.2.

Table 4.2 General Credits Allocation Scheme of UG Programs (Credit hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)	
II	10	3(5)	3(6)	1(3) + 2(7)	4	-	23	-	
Post-II semester						10(12)			
III	16	----		2(8)	2	-	20		
IV	12	3(9)	3 (10)	----	2	-	20	-	10
Post-IV semester						10(13)			
V	21	-	-	-	-	-	21	2(11)	
VI	21	-	-	-	-	-	21	-	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	112	9	6	8	12	20	167	4	10

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).

(2) Farming based Livelihood systems

(3) NCC/NSS; (4) Communication Skills; (5) Entrepreneurship Development and Business Management

(6) Environmental Studies and Disaster Management;

(7) Personality Development; (8) Physical Education, First Aid, Yoga Practices and Meditation.

(9) Agriculture Marketing and Trade; (10) Agriculture Informatics and Artificial Intelligence

(11) Study tour (10-14 days).

(12) Only for those opting for an exit with UG-Certificate. (13) Only for those opting for an exit with UG-Diploma

One multidisciplinary course in Agricultural Engineering discipline is different from the above common courses keeping in view the discipline specific requirement.

Note:

- The credit hours mentioned in the Table 4.2 include both theory and practical.
- The total credit allocation and the allocation for different types of courses including online courses for some disciplines such as Agricultural Engineering, Dairy Technology and Food Technology are slightly different than those mentioned in the Table 4.2, so as to accommodate the specific need of these disciplines.
- Also, some minor deviations in the courses and credits allocations are allowed across disciplines considering the specific nature of the courses.
- The three-year course curricula of all disciplines of agricultural and allied sciences do not cover the teaching of elective/ specialized courses, that in fact qualify the students in specializing in

a particular subject in which the student intends to do further studies. These courses have been presently listed under the 7th and 8th semesters (in IV year). Therefore, the Sixth Deans' Committee is of the view that the option of B. Sc. (Hons.) with research may lead to deficiency of the knowledge and learning of the elective / specialized subjects needed for PG studies. For B. Tech. programs, the framework prescribed by AICTE/ UGC may be applicable. Under such circumstances, the Committee recommends that the launching of UG degree with research should be deferred for the time being. ICAR may consider about this aspect along with considering restructuring PG/ Ph.D. programs. Also considering the professional nature of the courses, the exit after at the end of 3rd year (at the end of 6th semester) is not recommended.

- Each class (contact hour) will be of 50 min duration and one practical will be of two contact hours.
- If the student has to take up any deficiency course(s), that has to be satisfactorily completed within the first year.

4.3 Deeksharambh (Introduction- cum-foundation course)

The goal of higher education is to nurture students by blossoming their hidden potentials to pursue the academic and professional studies in a diligent, honest and responsible manner. It is possible by facilitating them to develop a sense of integrity with diverse faculties and build linkages with peers, society and community as a whole and lastly be proficient in earning livelihood independently along with sustaining society and nature.

A course entitled Deeksharambh (0+2) (Non-gradial) will be offered at the start of first semester for a duration of two weeks. This will be a part of first semester for all purposes including the calculation of Net Instruction Days (NIDs).

The goal of Deeksharambh is to inculcate life skills, develop bonding with mentors, peers and seniors, familiarize with institutional academic framework and functioning, It must educate students to explore their potentials and understand the purpose of their life with reference to serving the community, nation and global society.

Often the incoming undergraduate students are influenced by their parents and relatives to join higher studies, without understanding their own interests and talents. Therefore, the very purpose of initiating Deeksharambh: the induction cum foundation course is to acclimatize the student with the new surroundings, develop bond with fellow students and teachers. It is the time when a student should become clear as to what he/she/ze is going to study in a particular discipline, or even it is time to quit and join another discipline of his/ her choice. They must develop sensitivity towards various issues of social relevance and imbibe human values to become responsible citizens.

Thus, ensuring a well-designed Induction-cum-foundation program by the institutions shall be designed to become helpful to both teachers and students for setting the pace of productive teaching and learning experiences.

Four Pillars of Deeksharambh

Socializing: Meeting new students, senior students, attend lectures by Eminent People.

Associating: Visits to university / college, visits to Dept./Branch/ Program of study and important places on campus, local area, city and so on.

Acclimatizing with rules and regulations, student support system, etc.

Experiencing: Subject lectures, study skills, small-group activities, physical activity, creative and performing arts, literary activities, universal human values, etc.

Deeksharambh will create a platform for students to:

- learn from each other's life experiences,
- help for cultural integration of students from different backgrounds,
- know about the operational framework of academic process in university,
- instilling life and social skills,
- social awareness, ethics and values, team work, leadership, creativity, etc., and
- identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic and research managers.

Steps will be taken by the institutions to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds.

4.4 Common courses

The following common courses have been proposed to be offered across the disciplines, which in addition to giving the students a broader view of agriculture and allied sectors, will enable them for better communication skills and personality development. Besides, this will also help them to -- look beyond the boundaries of their own subject/ discipline, and collaborate in future with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade
- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics and artificial Intelligence

In addition to these common courses and Deeksharambh, the courses as Physical Education, First Aid, Yoga Practices and Meditation, NCC and NSS have also been made compulsory for students for improving social awareness, ethics, moral values and health of the future generation.

4.5 New age courses

Courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. Besides an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his interest. Emphasis has also been given to include the latest topics and subjects in both core and elective courses. Practical exercises

and pedagogy are proposed to make the next generation more imaginative, innovative, ingenious, creative and competent.

4.6 Deficiency courses

If the student has to take up any deficiency course(s), it has to be completed within the first year.

4.7 Entrepreneurship development

Entrepreneurship is a key driver of the economy of a nation, which has been encouraged through NEP-2020. Expectation is that an early orientation of the young minds towards skill enhancement and entrepreneurship will inculcate entrepreneurial mind set, allowing them to have first-hand experience of working with institutions, organizations, companies, industrial setup and investors so as to understand their dynamics in the real-world setting.

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP-2020, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

- Skill enhancement courses are included in following different modes:
- skill enhancement courses in the 1st year and 2nd year as part of the course programs;
- internship for exit programs after 1st year/ 2nd year; and
- advanced skill enhancement through Student READY: Experiential Learning/Hands on Training/Skill development/ RAWE/ Industrial attachment/IPT/ student project and Internship etc. in 4th year.

Internship can be seen as a mini capsule of intense learning for a student, a way to apply the theory into practice, expand their knowledge base and a platform to integrate all learnings of formal classroom setup.

Addition of new age courses related to Agriculture, Forestry, Fisheries, Agricultural Engineering, Community Science, Food Nutrition and Dietetics, etc., and incorporation of choice based online courses, which can be taken up from NPTEL, moo KIT, edX, Coursera, SWAYAM or any other portal in open digital learning environment. Practical exercises and teaching methodology are so designed to make the young generation more imaginative, innovative, ingenious, creative and competent.

The skill set acquired must make them proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field. This will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

4.7.1 Skill Enhancement Courses

The skill enhancement programs will be choice based; student can choose the areas of skill enhancement from a bouquet of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs/ farmers for running various skill enhancement programs.

In the report, for each discipline the list of Skill Enhancement Courses (SEC) has been suggested. The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources. In addition, the skill enhancement courses suggested by the UGC, as listed, may also be offered.

The evaluation of the skill enhancement programs will be as per the evaluation criteria of courses with only practical. However, for the internship programs, the evaluation will be done jointly by the host and parent organisations/ institutions.

4.7.2 Internship

The internship proposed under NEP-2020 have been an integral part of agricultural education (as proposed by Fifth Deans' Committee) under the broad category of Student READY programs. It includes various activities such as Experiential Learning/ Hands-on Training, Skill Development Training, Rural Agriculture Work Experience (RAWE), In-Plant Training/ Industrial Attachment and Students' Projects. Therefore, in the recommended structure, the student READY is further strengthened as per NEP-2020 guidelines.

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after second year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/ research institution/ project or with a progressive farmer/ agri enterprise, etc.

HAEIs will ensure that the Internship program is aligned with the course that the student has chosen. It is recommended that each HAEI appoints one or more Coordinators for the internship programs. The coordinator must plan/execute/ monitor internship programme implementation at the institution level.

4.7.3 Projects

For some disciplines, projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications, choose appropriate career in research or employment/ entrepreneurship, discover their interests, aptitudes and potentialities and maximise his/ her/ze potentialities and self-confidence. It will also add to creativity and critical thinking of the students. This will also help the students gain research skills and be more innovative in planning, executing, reporting and presenting the things.

4.8 Study tour

There will be a study tour of 10-14 days' duration during the 5th semester of the UG programme. The students will preferably visit the leading industries/ enterprises/ institutions/ organisations and

other places of academic interest outside the state (of location of the institution). This, in addition to exposing the students to the indigenous as well as the latest technologies in their related fields, will also help the students to know about the socio-economic-cultural variations within the country. The course will be of 0+2 credits, non-gradial.

4.9 Online courses

The students will have to take a minimum of 10 credits of online courses, which will comprise of one or more courses, as a partial requirement for the UG programme.

(As per UGC guideline, a 1- to 3- credit SWAYAM course is expected to be covered in 4-12 weeks' duration including the assessment component, in which it should be 40 hours for 3- credit courses to 80 hours for a 6-credit course for the learning from e-content, reading references material, discussion forum posting and assignment.)

The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc., and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. These can be taken any time during the duration of UG program, but preferably during the 3rd and 4th years.

The University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

The requirement of credits for online courses for B. Tech. programs is different due to the specific need of the disciplines.

4.10 Elective courses

The institutions will offer a bouquet of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report. The institutions will also have the liberty to develop and offer more Elective courses relevant to the subject as per local/ regional needs and available expertise. The elective courses can be offered from other disciplines in a Universality/HAEI.

4.11 Imparting Traditional Knowledge, Values and Ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the Deeksharambh, NCC and NSS. It is proposed the Study tour shall be conducted across the country to be aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

4.12 Introduction of new degree programs

Two new degree programs have been proposed in this report in two important areas.

Considering the natural strength of the country and future opportunities, a new UG course on Natural farming has been included. The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farmland ecosystem and reducing the market inputs. These important aspects of natural farming are considered as cost- effective and suitable for livelihood of large number of farmers and sustainable rural development.

A new degree programme on Agribusiness Management has been included. These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.

4.13 Light but tight educational programme

As per the norms of the NEP-2020, the programme has been made light but tight for the students. The total credit hours vary from 166-174 considering the specific need of the professional courses. At the same time, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning experience pleasurable and learning more efficient.

4.14 Moderation of courses at institution level

The following flexibility is allowed to the institutions for offering the courses:

A. Maximum 30% modification in the syllabus for any individual subject. It is recommended the HAEI should consider updating the course curricula around 5% every year. That would enable addition of new contents replacing obsolete/ old contents in the courses.

B. Formulation /addition/ change of Skill Enhancement modules as per needs/ facilities available.

C. Interchange of courses in between semesters within a year (but no change of course shall be normally allowed in between years).

D. Change of maximum two core courses (If any course is removed from the list of core course, it should be kept as elective), However, the total credit hours should not be lower than the prescribed.

E. Inclusion of any number of courses as Electives and freedom to offer the Elective courses.

F. Modification/ change of credit hours for any four courses (however, total credit hours should not differ by more than four).

G. In case the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

4.15 Central Assistance for strengthening higher agricultural education

The central Assistance for strengthening higher agricultural education, as proposed by the Fifth Deans' Committee, may be continued.

4.16 Admission Criteria

The eligibility and mode of admission for entry into the UG programs will be as per the prevailing ICAR/ SAU norms.

Agricultural universities/ colleges and other general universities offering agricultural disciplines, will fall under the umbrella of ICAR, as PSSB for agricultural education, as mandated by NEP-2020.

Institutions are at liberty to assess their student intake capacity, and announce the number of seats available in the first semester, and for lateral entries at 3rd semester and 5th semester.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in recognised institutions. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

There cannot be guarantee for migration to another HAEI. Institutions are at liberty to make their own decisions/ norms/guidelines on the matter of seats and admissions in 3rd and 5th semesters.

4.17 Provision of lateral entry for Diploma holders from recognised institutions

Candidates having a Diploma from polytechnics (after completion of 3 years course after 10th in related disciplines) will be entitled to take admission in the 2nd year (3rd semester) program. The HAEI may admit students either by holding its own admission test or use merit as criteria for by following any of the existing norms of the University/HAEI.

4.18 Migration from one University to other

The UG-Certificate/ UG-Diploma passed candidate from a HAEI will be eligible for admission into any agricultural university/institution in the country at appropriate level, provided the admitting university has provision of seats to admit them.

It is recommended to make institutional migration after 4th semester more convenient. HAEIs are at liberty to put in place rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students. The migration shall be subject to availability of seats at the accepting HAEI.

Provided further, any such rule/ regulation that is notified by UGC regarding changes in admission criteria, migration, etc., these notifications will be considered/ examined by ICAR and re-notified to make them applicable to agricultural education falling under its domain.

4.19 Exit Option

There will be three exits during the restructured UG programme.

Exit after 1st year: A student may opt to exit after the 1st year of UG programme. However, he/ she/ze has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 2nd year: A student may opt to exit after the 2nd year of UG programme. However, he/ she/ze has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-

Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 4-years programme leading to B.Sc. (Hons.)/ B.F.Sc. (Hons.)/ B. Tech. degree.

4.20 Maximum residential period

Students who exit with a UG- Certificate or UG- Diploma are permitted to re-enter within three academic years and complete the degree programme.

Students may be permitted to take a break from the study during the period of study but the total duration for completing the programme shall not exceed 7 years.

4.21 Examination and Evaluation system

There will be a uniform system of the evaluation and grading to be followed with Grade point average (GPA) system. The following pattern of examination is recommended.

Table 4.3 Evaluation system

	External theory	Internal theory (Mid-term)	Quiz/ progressive assessment	Final Practical
For courses having both theory and practical components	40%	20%	20%	20%
For courses with theory only	50%	30%	20%	-
Courses with practical only	-	30%	20%	50% (Internal)

For the external theory examinations, the question paper will be obtained from external experts. The HoDs of the respective departments will ensure due coverage of the syllabus with the provision of moderation, if necessary. Paper evaluation to be done by a faculty other than the course instructor(s).

The external theory examinations should be of 2 to 2.5 hours' duration and the mid-term examinations should be normally of 1-hour duration. The format of assessment and duration of quizzes/ progressive assessment duration will depend upon the course teacher.

Internal practical examination to be conducted by the course instructor and one faculty nominated by the HoD of the concerned department.

The evaluation of the skill enhancement courses will be done as courses with practical only.

Usually for any subject, there will be two quizzes within the semester, one before the mind-term and one after. There will be provision of corrections in between, i.e. the students scoring lower than 50% marks in any one quiz can opt for appearing for a third quiz to improve their grades. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in form of group assignments (which should encourage creativity, critical thinking and problem-solving attitude).

The evaluation of internship will be done both by the parent institute and the host industry/ organisation. It should be 50% weightage for each. The student shall submit a report to the parent

institute and present the learnings before the other students and faculty after the internship programme. The format of evaluation may be developed by the parent institute.

The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' remark.

When students take deficiency course(s), they will be assessed as 'Satisfactory' or 'Un-satisfactory' without any grade points.

The evaluation will be done on a 10-point scale.

10 point = 100 marks

The per cent of marks in a subject will be divided by 10 to obtain the grade point.

The grade point average for a semester will be calculated as follows.

$$GPA = \frac{\sum (Grade\ \ p\ \ \text{int} \times credit\ \ hours)_{\text{in one semester}}}{Total\ \ credit\ \ hours \text{ in the semester}}$$

The Cumulative grade point earned at any stage of the course will be calculated as cumulative grade point average (CGPA) as follows.

$$\text{CGPA} = \frac{\sum (\text{Grade p int} \times \text{credit hours})_{\text{until last semester}}}{\text{Total credit hours until last semester}}$$

If a student passes in a subject in a second attempt, for calculation of CGPA, the grade point for the subject in the second attempt will only be considered. The final CGPA will be named as overall grade point average (OGPA), which will be mentioned in the final transcript of the students.

4.22 Award of Divisions

The award of the divisions will be as follows

Table 4.4 Award of the divisions

OGPA	Division
5 to <6	Pass
6 to <7	II division
7 to<8	I Division
>=8	1st division and distinction

4.23 Uniformity in Nomenclature of Degrees

To ensure hassle free movement of students throughout the country, it is important that nomenclature of degrees awarded is same, across all HAEIs. The nomenclature will be as follows.

a. UG-Certificate with mention of discipline

e.g. UG-Certificate in Agriculture, UG-Certificate in Horticulture, UG-Certificate in Agricultural Engineering

Note: If any institution is at present offering any certificate course of the duration of one year lower, it may continue to do so, but this certificate course will not be considered at par with

the UG-Certificate, if the student has not taken admission through the appropriate entrance examination for entry into the 4-year UG program.

b. UG-Diploma with mention of discipline

e.g. UG-Diploma in Agriculture, UG-Diploma in Horticulture, UG-Diploma in Agricultural Engineering

Note: If any institution is at present offering any Diploma course of two years or less than two years' duration after +2 Science, it may continue to do so, but this diploma course will not be considered at par with the UG-Diploma, if the student has not taken admission through the appropriate entrance examination for entry into the 4-year UG program.

The nomenclature of undergraduate degrees will be as per the recommendations of the 5thDeans' Committee as follows:

B. Sc. (Hons.)/ B. F. Sc. (Hons.)/ B. Tech. followed by discipline

e.g. B. Sc. (Hons.) Agriculture/ B. F. Sc (Hons.)/ B. Tech. (Agricultural Engineering)

The nomenclature of degrees may change in case any such revision is suggested by the UGC.

4.24 Increasing Gross Enrolment Ratio (GER)

Keeping in view the NEP-2020 call for increasing GER, it is recommended that provision is made by institutions to launch stand-alone UG-Certificate and/ or UG-Diploma courses in specific subjects/ disciplines. The entrance examinations for such programs will be separate. The students completing the UG-Certificate will have to appear separate entrance test for continuing to higher level as per University/HAEI norms. Similarly, the students completing the UG-Diploma will have to appear separate entrance test for continuing to higher level as per University/HAEI norms.

4.25 Academic Bank of Credits (ABC)

As per NEP-2020 guidelines, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/ NEP-2020 recommendations.

4.26 Blended learning

Blended learning has gained tremendous popularity as it combines the benefits of traditional classroom teaching with emerging technology and online educational resources to make learning more real-time, contextual, and engaging. This provision will enable blended learning to expand the open /distance learning options and to promote extensive use of technology in learning and skilling. This would help in overcoming the constraints of physical infrastructure and scalability while enhancing access, equity, and affordability and ensuring quality and accountability. The blended learning option shall also enhance accessibility of learning for Divyangs.

4.27 Minimum requirement for establishing colleges for agriculture and allied disciplines

The minimum requirements for establishing colleges for 13 agricultures and allied disciplines shall be as per the ICAR Model Act-2023 and various guidelines and orders being issued by ICAR from time to time.

The new NEP-2020 has been introduced in the country to formalize changes in the system, from school to college/ university level. Keeping in mind the concurrent developing scenario and stakeholders' demands, especially in agriculture education, research and extension systems across the regions, delivery of education content henceforth, will focus on key-concepts, ideas, applications and problem-solving angles so as to empower students to become employment ready.

The Indian Council of Agricultural Research has been declared Professional Standards Setting Body (PSSB) for agriculture and allied subjects under NEP-2020. The Council has been coordinating with all agricultural universities since 1960s or so for addressing the issues of quality agricultural education. Primary focus of national coordination in agricultural education was given to update course curricula periodically and concerned universities to adopt them. As a result of long term persuasions by ICAR and realization of stakeholders' demand, agricultural universities have been implementing ICAR recommended Course Curricula for 13 undergraduate programs, 80 Post Graduate programs and 79 Ph. D. programs.

Later on, it was perceived that merely changing the course curricula would not be sufficient to address the quality education, but a sound framework suggesting minimum requirements for degree programs especially requirements of teaching and non-teaching staff, instructional laboratory and instructional farms and supporting units of the following disciplines are also equally essential:

1. Agriculture
2. Agricultural Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries Science
6. Food Technology
7. Forestry
8. Community Science
9. Horticulture
10. Food Nutrition and Dietetics
11. Sericulture
12. Agribusiness Management
13. Natural Farming

4.28 Making implementation of the recommendations of the Deans' Committee mandatory

Efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programs and academic institutions by the National Agricultural Education Accreditation Board (NAEAB).

5. COMMON COURSES

***Deeksharambh* (Induction-cum-Foundation Programme)** **0+2 (NG)**

Objective

- To give a broad view and application areas of the subject of study
- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in university
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

Activities

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario

iii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iv. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Farming based Livelihood Systems

3 (2+1)

Objective

i) To make the students aware about farming-based livelihood systems in agriculture

ii) To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum

Fish, Piggery cum Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural-based livelihood enterprises, Study of components of important farming- based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA

2. Ashley, C.; Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7. [Google Scholar]

3. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
4. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
5. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
6. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
7. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna 800 014, Bihar.
8. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
9. Evenson, R.E. 2000. Agricultural Producitivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
10. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India

Entrepreneurship Development and Business Management 3(2+1)

Objective

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal

management–manpower planning, labour turn over, wages / salaries. Financial management / accounting–funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

- Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai, V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
- Desai, Vasant. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
- Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
- Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
- Khanka, S.S. 1999. Entrepreneurial Development. S. Chand & Co.
- Mehra, P. 2016. Business Communication for Managers. Pearson India, New Delhi.
- Pandey, M. and Tewari, D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
- Singhal, R.K. 2013, Entrepreneurship Development & Management, Katson Books.
- Tripathi, P.C. and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill.

Agriculture Marketing and Trade 3 (2+1)

Objective

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales

promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA), and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna, S.S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N. 2002. Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2005. Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Singh, Joginder. 2006. Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey, Mukesh and Tewari, Deepali. 2004. Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R. 2005. Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objective

i) To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.

i) To provide basic knowledge of computer with applications in agriculture

iii) To make the students familiar with agricultural-informatics, its components and applications in agriculture and Artificial intelligence

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system,

Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa.

Environmental studies and disaster management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters.

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources. Introduction to Environment - Environmental studies-Definition, scope and importance -Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global

warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act.

Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/ Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T., Vennila, S., Prasanthrajan, M. Umesh and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur
6. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerat, India
7. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/ Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G. W. 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar, S. and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James, W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
9. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1) Andrews, Sudhir. 1988. How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.
2) Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3) Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4) Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5) Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6) Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
7) Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor

Physical Education, First Aid, Yoga Practice and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general well being through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga:

- Asanas: Definition and Importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

NCC-I 1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NCC-II 1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and

holding.

- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- I **1 (0+1)**

Objective

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

NSS-II **1 (0+1)**

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilled in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

6. UGC Skill Courses

UGC recommended list of skill development training areas

In addition to skill development training courses identified by respective universities from respective disciplines of study, such as agriculture, agribusiness, horticulture, forestry, etc. Skill development courses may also be selected by universities from the following list of skill trainings advised in the UGC notification. "Guidelines for the Introduction of Short -Term Skill Development Courses in Higher Educational Institutions". The university/ college may select any number of short-term skill development courses from the broad areas as mentioned below, in which they will have built institutional capacity for training or joined partnership with specialized institution capable of imparting such training program. The courses may be planned as integrated part of the UG-Certificate and UG-Diploma Programmes (after suitable planning of the contents) or they may be offered in stand-alone mode leading to award of certificates on the skill areas.

i. Artificial Intelligence, and machine learning
ii. Artificial Intelligence, and Robotics
iii. IoT (Internet of Things)/ Industrial IoT/Smart Cities
iv. Data Science and Analytics
v. Cloud Computing
vi. Virtual Reality, Augmented Reality and Extended Reality
vii. Cyber Security and Digital Forensics
viii. 5G Connectivity
ix. Digital Fluency/ Digital transformation
x. Industrial Automation and Robotics Process Automation (RPA)
xi. Electronic System Designs/ VLSI Designs
xii. Electronic Manufacturing
xiii. Basic Coding in Computing Languages
xiv. Computer-Aided Design (CAD)/Computer-Aided Manufacturing (CAM)
xv. Mechanical Tooling and Processes/ Mechatronics
xvi. Architectural Drafting, Basic 3D Design
xvii. Building Information Modelling (BIM)
xviii. 3D Printing
xix. Electrician/Electrical and Electronics
xx. Mobile Communication, Mobile Repairing and Basics of DTH Installation

xxi. Digital Marketing - courses in Search Engine Optimization (SEO), social media marketing, content marketing, and e-commerce management

xxii. Health and Wellness - courses focusing on mental health counselling, nutrition and dietetics, and fitness training in response to the growing awareness of personal well-being and holistic health and wellness

xxiii. Financial Technology (FinTech) - courses in digital payments, blockchain technology, digital currencies, and financial regulations

xxiv. Fashion Technology, Fashion design, stitching, etc. (home science colleges)

xxv. Yogic Sciences

xxvi. Soft skills and courses in effective communication, critical thinking and problem-solving, creative thinking and innovation, novel and adaptive thinking, design thinking and mindset, computational thinking, virtual collaboration, cross-cultural competency, new media literacy, team building, etc.

xxvii. Basics of start-ups and Entrepreneurship – leadership, project planning, management, Event Management, marketing, financing, and agri-business entrepreneurship, etc.

The university / college may also offer short-term courses in any other areas identified by it, based on the skill gap studies as well as institutional expertise, e.g. agriculture, horticulture, home science etc. The skill courses run by various Sector Skill Councils can also be adopted.

Syllabi of Different Disciplines

AGRICULTURE

Course Curricula for Undergraduate programme in Agriculture UG-Certificate in Agriculture UG-Diploma in Agriculture B.Sc. (Hons) Agriculture

INTRODUCTION

Present report is an outcome of the valuable suggestions and recommendations of Sixth Deans' Committee members after having multi-stage in-depth deliberations and discussions in virtual and physical meetings as well as personal communications with the Deans and faculty members of the Agriculture discipline of different SAUs and Central Agricultural Universities, stakeholders from related industries, Government Institutions, alumni and students of the existing course programme across the country.

Restructuring of Undergraduate programme of Agriculture has been carried out as per National Education Policy-2020 guidelines to build among students, a strong foundation of knowledge and increased practical exposure to instil competence and confidence for application of the professional knowledge coupled with hard and soft skills. New scientific advancements in the field of agriculture have been also given due emphasis with inclusion of courses with contents from such areas.

More emphasis has been given on Skill Enhancement Courses, industry attachments, flexibility in choice of courses via electives offered in fourth year and also through online courses along with provision of project work and internship. Provision of UG-Certificate in Agriculture, UG-Diploma in Agriculture and B.Sc. (Hons) Agriculture degree with internship with amalgamation of multiple exit and entry options as per NEP-2020 is important change in the course curriculum.

The detailed report on undergraduate courses of Agriculture viz. UG-certificate in Agriculture, UG-diploma in Agriculture and B.Sc. (Hons) Agriculture has been prepared with due care and inputs of Deans, Heads and faculty members of various departments of agriculture nationwide.

HIGHLIGHTS

- The B. Sc (Hons) Agriculture program will be of 177 credits, which will have 167 credits offered by the parent university and 10 credits of online courses taken by the student as per choice in consultation with university/HAEIs.
- After the admission in the college, the students will register for the Foundation programme of 2 weeks' duration in the 1st semester. A course entitled Deeksharambh (0+2) (Non-gradial) will be offered at the start of first semester for two weeks' duration. This will create a platform for students to learn from each other's life experiences, help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instilling life and social skills, social awareness, ethics and values, team work, leadership, creativity, etc. It will also help in identifying the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario. There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the university academic and research managers.
- The first year of the course program comprises skill development courses along with other fundamental courses of agricultural science. After satisfactory completion of 42 credits of courses in two semesters of 1st year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Agriculture on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the skill development courses, basic courses as well as fundamental courses in agriculture with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural sciences. After satisfactory completion of the courses (84 credits) during first two years and subsequent satisfactory completion of 10 credits (10 weeks) of internship, the student will become eligible for the award of UG-Diploma in Agriculture on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- During the 5th semester, the students will have a study tour of 10-12 days duration, which will be counted as 2 credits (Non-gradial).
- The third- and fourth- year courses have been designed to impart specialized knowledge to the students in the major disciplines. During the 7th semester, the students will adequately select 20 credits from a basket of elective courses, each course being of 4 credits giving an opportunity to them to gain advanced knowledge in frontier areas of agricultural science. The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.
- In the 8th semester of the course the major focus has been on strengthening of the knowledge and skill for developing confidence of the students to take entrepreneurship as their future

career. For this they will undergo an advanced skill enhancement through Student READY: RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship. A student will select option/s on choice to complete the degree and pursue future career with 20 credits. Each student will be attached to a mentor either from the institution or from an organization/ industry. A university or a college will have the freedom to select the options as referred above.

- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.
- The students will take a minimum of 12 credits of online courses during four years as a partial requirement for the B.Sc. (Hons) Agriculture program. The indicative list of courses has been provided; however, online courses can be from any field such as Agriculture and allied sciences, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Mook IT, edX, Coursera, SWAYAM or any other such reputed portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial and separate certificates would be issued by institute/organization offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and indicate the title of the (successfully completed) courses in final transcript issued to the student. A student must submit the list of online courses along with the content he intends to undertake to the Dean/Assoc. Dean/Principal of the college for a permission and records.
- At each stage of exit (UG-certificate/ UG-Diploma and B.Sc. (Hons) Agriculture, the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own enterprise. The social skills acquired by the students will also make the students more empathetic towards the society and social issues.
- The credits (and contact hours) have been designed in such a way that along with class room teaching, the students will take up NSS/ NCC and Physical Education, Yoga, etc. in the first year as the case may be. Further a balance has been made by inclusion of common courses, core courses in basic and applied areas, skill development courses, elective courses in advanced areas, online courses of choice, options for entrepreneurship and skill development to pursue future career. This will increase their acquaintance with the social/ technical problems, improve their analytical ability of the issues/ challenges and enhance their social responsibility.

Entry and Exit Options

The entry and exit options for the UG programme in Agriculture are shown in the Fig.-1 below.

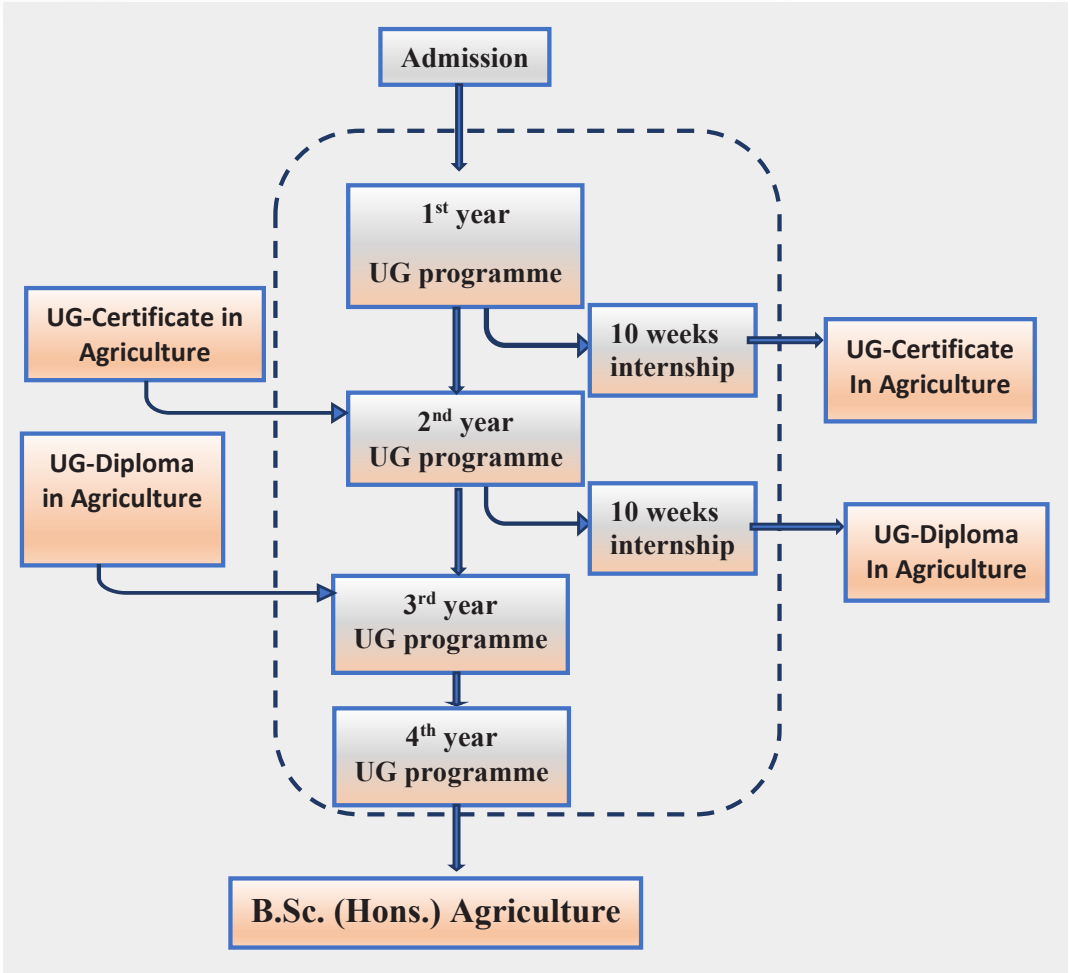

Fig. 1 Entry and Exit options for the UG programme in Agriculture

Exit options

1. **UG-Certificate in Agriculture** (exit after first year and completion of 10 weeks' internship)
2. **UG-Diploma in Agriculture** (exit after second year and completion of 10 weeks' internship)
3. **B.Sc. (Hons) Agriculture** (on successful completion of four-year degree requirements)

Eligibility for Entry into 1st year UG programme: +2 Science with biology as one subject

Provision for multiple exit and entry into the UG programme in agriculture has been made in the light of NEP-2020. A student may exit after completion of 1st year and 2nd year requirements followed by 10 weeks of internship after 1st year and 2nd year, respectively, to get UG-Certificate in Agriculture and UG-Diploma in Agriculture.

The Universities may consider allowing lateral entry for the candidates having Diploma in Agriculture (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having Diploma in Agriculture (with minimum 3 years

course programme after 10th or equivalent) may be allowed admission into the 2nd year of the UG programme, as per the provisions and norms to be notified by the respective AU from time to time.

ACADEMIC PROGRAMME

Semester wise course and credits Allocation

S. No	Course Title	Credit Hours	Total credit hours
	First year		
	I Semester		
1	*Deeksharambh* (Induction cum Foundation course)	1 week (NG) Non-gradial	**21(11+10)**
2	Skill Enhancementcourse-I*	2(0+2)	
3	Skill Enhancementcourse-II*	2(0+2)	
4	Communication Skills	2(1+1)	
5	Farming based livelihood systems	3(2+1)	
6	Rural Sociology and Educational Psychology	2 (2+0)	
7	Fundamentals of Agronomy	3(2+1)	
8	Fundamentals of Soil Science	3(2+1)	
9	Fundamentals of Horticulture	3(2+1)	
10	National Service Scheme (NSS-I)/ National Cadet Corps (NCC-I)	1(0+1)	
11	Introductory mathematics (need based)	1(1+0) Non-gradial	
	II Semester		
1	Skill Enhancement course-III*	2(0+2)	**21(10+11)**
2	Skill Enhancement course-IV*	2(0+2)	
3	Personality Development	2(1+1)	
4	Environmental Studies and Disaster Management	3(2+1)	
5	Soil Fertility Management	3(2+1)	
6	Fundamentals of Entomology	3(2+1)	
7	Livestock and Poultry Management	2(1+1)	
8	Fundamentals of Plant Pathology	3(2+1)	
9	NCC-II/NSS-II	1(0+1)	
	Second year		
	III Semester		
1	Skill Enhancement course-V*	2(0+2)	**21(9+12)**
2	Entrepreneurship Development and Business Communication	3 (2+1)	
3	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	
4	Principles of Genetics	3(2+1)	
5	Crop Production Technology-I (*Kharif* crops)	3(1+2)	
6	Production Technology of Fruit and Plantation Crops	2 (1+1)	
7	Fundamentals of Extension Education	2(1+1)	
8	Fundamentals of Nematology	2(1+1)	
9	Principles and Practices of Natural Farming	2(1+1)	

	IV Semester		
1	Skill Enhancement course-VI*	2(0+2)	
2	Agricultural Informatics and Artificial Intelligence	3(2+1)	
3	Production Technology of Vegetables and Spices	2(1+1)	
4	Principles of Agricultural Economics and Farm Management	2(2+0)	
5	Crop Production Technology-II (*Rabi* Crops)	3(1+2)	
6	Farm Machinery and Power	2 (1+1)	
7	Water Management	2 (1+1)	**21(11+10)**
8	Problematic Soils and their management	2(1+1)	
9	Basics of Plant Breeding	3(2+1)	
	Third year		
	V Semester		
1	Agricultural Marketing and Trade	3 (2+1)	
2	Introduction to Agro-meteorology	2(1+1)	
3	Fundamentals of Crop Physiology	3(2+1)	
4	Pest management in Crops and Stored Grains	3 (2+1)	
5	Diseases of Field & Horticultural Crops & their Management	3(2+1)	
6	Crop Improvement (*kharif* crops) - I	2 (1+1)	
7	Weed Management	2(1+1)	
8	Ornamental Crops, MAPs and Landscaping	2 (1+1)	**22(13+9)**
9	Introductory Agro forestry	2 (1+1)	
	VI Semester		
1	Fundamentals of Agri Biotechnology	3(2+1)	
2	Basic and Applied Agril Statistics	3(2+1)	
3	Crop Improvement (*Rabi* crops) - II	2(1+1)	
4	Renewable energy in Agriculture and Allied Sector	2(1+1)	
5	Dryland agriculture/ Rainfed agriculture and watershed management	2(1+1)	
6	Agricultural Microbiology and Phyto -remediation	2(1+1)	
7	Agricultural Finance & Cooperation	2(1+1)	
8	Essentials of Plant Biochemistry	3 (2+1)	**21(12+9)**
9	Fundamentals of Seed Science & Technology	2(1+1)	
	Fourth year		
	VII Semester		
1	5 Elective Courses (major or minor) each of 4 (3+1) credits for B.Sc. (Hons) Agriculture degree		**20(15+5)**
	VIII Semester		
1	For B.Sc. (Hons)Agriculture Degree Student READY :RAWE/ Industrial Attachment /Experiential Learning / Hands-on Training/ Project Work / Internship		**20 Credits**
		Total	**167**
	***Online courses**	10	**10**
		Grand Total	**167+10***

* From the bouquet of Skill Enhancement Course (SEC) modules

Department/section wise course breakup

S. No	Course title	Credit Hours	Total
	Agronomy		
1	Fundamentals of Agronomy	3 (2+1)	**22 (11+11)**
2	Farming based livelihood systems	3 (2+1)	
3	Crop Production Technology-I (*Kharif* Crops)	3 (1+2)	
4	Crop Production Technology-II (*Rabi* Crops)	3(1+2)	
5	Water Management	2 (1+1)	
6	Weed Management	2 (1+1)	
7	Introductory Agro forestry	2 (1+1)	
8	Dryland agriculture/ Rainfed agriculture and watershed management	2 (1+1)	
9	Principles and Practices of Natural Farming	2 (1+1)	
	Soil Science:		
1	Fundamentals of Soil Science	3 (2+1)	**8 (5+3)**
2	Soil Fertility Management	3 (2+1)	
2	Problematic Soils and their management	2 (1+1)	
	Horticulture		
1.	Fundamentals of Horticulture	3 (2+1)	**9 (5+4)**
2.	Production Technology of Fruit and Plantation Crops	2 (1+1)	
3.	Production Technology of Vegetables and Spices	2 (1+1)	
4.	Ornamental Crops, MAPs, and Landscaping	2 (1+1)	
	Genetics and Plant Breeding		
1.	Principles of Genetics	3 (2+1)	**12 (7+5)**
2.	Basics of Plant Breeding	3 (2+1)	
3.	Crop Improvement (*Kharif* crops) - I	2 (1+1)	
4.	Crop Improvement (*Rabi* crops)- II	2 (1+1)	
5.	Fundamentals of Seed Science and Technology	2 (1+1)	
	Entomology		
1.	Fundamentals of Entomology	3 (2+1)	**6 (4+2)**
2.	Pest management in Crops and Stored Grains	3 (2+1)	
	Plant Pathology		
1.	Fundamentals of Plant Pathology	3 (2+1)	**8 (5+3)**
2.	Diseases of Field & Horticultural Crops & their Management	3 (2+1)	
3.	Agricultural Microbiology and Phyto-remediation	2 (1+1)	
	Extension Education		
1.	Rural Sociology and Educational Psychology	2 (2+0)	**8 (5+3)**
2.	Fundamentals of Extension Education	2 (1+1)	
3.	Communication skills	2 (1+1)	
4.	Personality development	2 (1+1)	
	Agricultural Meteorology		
1.	Environmental Studies and Disaster mgt.	3 (2+1)	**5 (3+2)**
2.	Introduction to Agro-meteorology	2 (1+1)	

	Agricultural Economics		
1.	Principles of Agricultural Economics and Farm Management	2 (2+0)	**9 (6+3)**
2	Entrepreneurship Development and Business Communication	3 (2+1)	
3	Agricultural Marketing and Trade	2 (1+1)	
4.	Agricultural Finance & Cooperation	2 (1+1)	
	Agricultural Statistics		**6 (4+2)**
1.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
2.	Basic and Applied Agril Statistics	3 (2+1)	
3.	Introductory Mathematics	1 (1+0)	Non gradial
	Agricultural Engineering		
1.	Farm Machinery and Power	2 (1+1)	
2.	Renewable energy in Agriculture and Allied Sector	2 (1+1)	**4 (2+2)**
	Nematology		
1.	Fundamentals of Nematology	2 (1+1)	**2 (1+1)**
	Biochemistry		
1.	Essentials of Plant Biochemistry	3 (2+1)	**3 (2+1)**
	Crop Physiology		
1.	Fundamentals of Crop Physiology	3 (2+1)	**3 (2+1)**
	Animal Husbandry		
1.	Livestock and poultry Management	2 (1+1)	**2 (1+1)**
	Agricultural Bio-technology		
1.	Fundamentals of Agri Biotechnology	3 (2+1)	**3 (2+1)**
1.	**Students' Welfare** NCC/NSS	 1 (0+1)	**1 (0+1)**
2.	NCC/NSS	1 (0+1)	**1 (0+1)**
3.	Physical Education, First Aid and Yoga Practices	2 (0+2)	**2 (0+2)**
4.	Study Tour	2 (0+2)	**2 (0+2)** Non gradial
	***Elective Courses (Indicative)**		
1	Agri-Business Management	4 (3+1)	**20*(15+5)** 5* Elective Courses
2	Management of natural resources	4 (3+1)	
3	Agrochemicals	4 (3+1)	
4	Agricultural Journalism	4 (3+1)	
5	Landscaping	4 (3+1)	
6	Commercial Plant breeding	4 (3+1)	
7	Food safety and standards	4 (3+1)	
8	Bioformulation and Nano formulation	4 (3+1)	
9	Biopesticides and Biofertilizers	4 (3+1)	
10	System Simulation and Agro advisory	4 (3+1)	
11	Hi-tech Horticulture	4 (3+1)	
12	Protected cultivation	4 (3+1)	
13	Climate Resilient Agriculture	4 (3+1)	
14	Biotechnology of Crop Improvement	4 (3+1)	
15	Geoinformatics and Remote Sensing, precision farming	4 (3+1)	
16	Micro-propagation Technologies	4 (3+1)	
17	Commercial Seed Production	4 (3+1)	
18	Principles and Practices of Organic Farming/ Conservation Agriculture	4 (3+1)	
19	Food Science and Nutrition	4 (3+1)	
20	Post-Harvest Technology and Value Addition		
****Skill enhancement courses (SECs)**			

1.	SEC-I	2 (0+2)	**12 (0+12)**
2.	SEC-II	2 (0+2)	
3.	SEC-III	2 (0+2)	
4.	SEC-IV	2 (0+2)	
5.	SEC-V	2 (0+2)	
6.	SEC-VI	2 (0+2)	

***Host institution may add more courses into this list**
**** SEC will be decided by host institution depending on strength**

Summary of credit distributions among different categories of courses (Credit hours)

Semester	Core Courses (Major and Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhance-ment Course (AEC)	Skill En-hancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non gradial	Internship	Online course/ MOOC
I	11	**3**(3)	___	1(4)+2(5)	4		21	2(1)+1(2)	----	**10**(15)
II	11	---	3(6)	1(4)+2(7)	4		21		10(13)	
III	14	3(8)	---	2(9)	2		21		---	
IV	16	---	3(10)	----	2		21		10(14)	
V	19	3(11)	----	----	----		22	2(12)	----	
VI	**21**	_	---	---	---		21		---	
VII	**20**	--	--	---	--		20		--	
VIII		--	--	---	--	20	20			
Total	**112**	**9**	**6**	**8**	**12**		**167**	**4**	**20**	10

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Remedial Course: Mathematics of 1 credit
(3) Farming based Livelihood systems
(4) NCC/NSS
(5) Communication Skills
(6) Environmental Studies and Disaster management
(7) Personality development
(8) Entrepreneurship Development and Business Management
(9) Physical Education, First Aid and Yoga Practices
(10) Agricultural Informatics and Artificial Intelligence
(11) Agricultural Marketing and Trade
(12) Study tour (10-14 days)
(13) Only for those opting for an exit with UG-Certificate and
(14) Only for those opting for an exit with UG-Diploma
(15) Online course: student will make his own planning and execution of online courses with intimation to the Dean

Summary of Credit Distributions

Type of courses		Credits
Core courses (Major & Minor/s)	:	112
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	**167+10****

List of Courses as per above Categories

Course category	Course title	Credit Hours
Induction cum Foundation course	*Deekshaarambh*	2 weeks (Non-gradial)
Common courses	Farming based livelihood systems	3 (2+1)
	Communication skill	2 (1+1)
	Personality development	2 (1+1)
	Environmental studies and disaster management	3 (2+1)
	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Entrepreneurship Development and Business Management	3 (2+1)
	Agricultural Marketing & Trade	3 (2+1)
	NSS/ NCC-I	2 courses each of 1 (0+1) credits
	Physical Education, First Aid and Yoga Practices	2 credits
	Total credits	**23**
Core Courses	Fundamentals of Agronomy	3 (2+1)
	Crop Production Technology-I (*Kharif* Crops) including Practical Crop Production	3 (1+2)
	Crop Production Technology-II (*Rabi* Crops) including Practical Crop Production	3 (1+2)
	Water Management	2 (1+1)
	Weed Management	2 (1+1)
	Introductory Agro forestry	2 (1+1)
	Dryland agriculture/ Rainfed agriculture and watershed management	2 (1+1)
	Principles and Practices of Natural Farming	2 (1+1)
	Fundamentals of Soil Science	3 (2+1)
	Soil Fertility Management	3 (2+1)
	Problematic Soils and their management	2 (1+1)
	Fundamentals of Horticulture	3 (2+1)
	Production Technology of Fruit and Plantation Crops	2 (1+1)
	Production Technology of Vegetables and Spices	2 (1+1)
	Ornamental Crops, MAPs, , and Landscaping	2 (2+1)
	Principles of Genetics	3 (2+1)
	Basics of Plant Breeding	3 (2+1)
	Crop Improvement (*kharif* crops)- I	2 (1+1)
	Crop Improvement (*Rabi* crops)- II	2 (1+1)
	Fundamentals of Seed Science Technology	2 (1+1)
	Fundamentals of Entomology	3 (2+1)
	Pest management in Crops and Stored Grains	3 (2+1)
	Fundamentals of Plant Pathology	3 (2+1)

Course category	Course title	Credit Hours
	Diseases of Field & Horticultural Crops & their Management	3 (2+1)
	Agricultural Microbiology and Phyto -remediation	2 (1+1)
	Rural Sociology and Educational Psychology	2 (2+0)
	Fundamentals of Extension Education	2 (1+1)
	Introduction to Agro-meteorology	2 (1+1)
	Principles of Agricultural Economics and Farm Management	2 (2+0)
	Agricultural Finance & Cooperation	2 (1+1)
	Basic and Applied Agril. Statistics	3 (2+1)
	Farm Machinery and Power	2 (1+1)
	Renewable energy in Agriculture and Allied Sector	2 (1+1)
	Fundamentals of Nematology	2 (1+1)
	Essentials of Plant Biochemistry	3 (2+1)
	Fundamentals of Crop Physiology	3 (2+1)
	Livestock and poultry Management	2 (1+1)
	Fundamentals of Agri Biotechnology	3 (2+1)
	TOTAL	**92**
Elective Courses	20 credits will be taken from list of choice based course list or department wise courses to be decided by host institution	20
	TOTAL	**20**
Skill Enhancement Courses **(indicative)**	SDC-I (Biofertlizer and biopesticide production)	2 (0+2)
	SEC-II (Mushroom production technology)	2 (0+2)
	SEC-III (Seed Production Technology)	2 (0+2)
	SEC-IV (Post harvest processing technology)	2 (0+2)
	SEC-V (Beneficial insect farming)	2 (0+2)
	SEC-VI (Horticulture nursery management)	2 (0+2)
	SEC-VII (Plantation crops production and management)	2 (0+2)
	TOTAL	**12**
Students READY		10+10
	TOTAL	**20**
Other courses	Remedial course on 1. Mathematics	1 credit Non-gradial
	Study tour (2 weeks in 5th semester)	2 (0+2) Non-Gradial
	Total for offline course credits	**167**
Online courses	*Online courses	**10**
	Grand Total	**167+10***

DETAILED SYLLABI

Semester 1

Deeksharambh (Induction-cum-Foundation Course)-Non gradial 1 (1+0)

Objectives

- Help for cultural integration of students from different backgrounds,
- Know about the operational framework of academic process in the University/College/Institute
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.
- Identify strength and weakness of the students in different core areas of the discipline.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in the University, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Communication Skills 2 (1+1)

Objectives

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process**:** The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar**:** Sentence structure, modifiers, connecting words and verbal; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G. W.1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. Business Communication. Oxford University Press.
9. Seely J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V. 1977. A Practical English Grammar. Oxford University

Farming based livelihood systems **3 (2+1)**

Objective

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish

etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar]
2. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, AmitavaDeyUjjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.

10. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Rural Sociology and Educational Psychology 2 (2+0)

Objective

Provide knowledge on concept and importance of sociology and rural sociology as well as the relationship with Extension Education

Theory

Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. Sociology and rural sociology: Meaning, definition, scope, importance of rural sociology in Agricultural Extension, and interrelationship between rural sociology and Agricultural Extension. Indian Rural Society: important characteristics, differences and relationship between rural and urban societies. Social Groups: Meaning, definition, classification, factors considered information and organization of groups, motivation in group formation and role of social groups in Agricultural Extension.

Social Stratification: Meaning, definition, functions, basis for stratification, forms of social stratification- characteristics and- differences between class and caste system. Cultural concepts: culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. Social Organizations: Meaning, definition, types of organizations and role of social organizations in agricultural Extension. Social Control: Meaning, definition, need of social control and means of social control. Social change: Meaning, definition, nature of social change, dimensions of social change and factors of social change. Leadership: Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders. Training of Leaders: Meaning, definition, methods of training, Advantages and limitations in use of local leaders in Agricultural Extension, Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Intelligence: Meaning, definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Personality: Meaning, definition, types, factors influencing the personality and role of personality in agricultural Extension. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested readings

1. A. R. Desai -Rural Sociology in India
2. Dahama O. P. and Bhatnagar, O. P. - Education and Communication for Development
3. J.B. Chitambar -Introductory Rural Sociology
4. M.B. Ghorpade- Essential of psychology
5. Prepared You Tube videos
6. R Velusamy Textbook on Rural Sociology and Educational Psychology

7. Ray, G. L. -Extension Communication and Management
8. Sandhu A. S. -Textbook on Agricultural Communication
9. Web Materials

Fundamentals of Agronomy 3 (2 +1)

Objectives

To impart the basic and fundamental knowledge of Agronomy

Theory

Agronomy and its scope: Definition, meaning and scope of Agronomy; art, science and business of crop production, relation of Agronomy with other disciplines of Agricultural Science, fields crops and classification, importance, ecology and ecosystem. Seeds and sowing: Definitions of crops, variety and seed. Factors affecting crop stands establishment: good quality seed, proper tillage, time of sowing seed rate, depth and method of sowing: broadcasting, drilling, dibbling, transplanting etc. Tillage and tilth: Definition, objectives, types, advantages and disadvantages of tillage including conservation tillage. Crop density and geometry: plant geometry and planting geometry, its effect on growth, yield.

Crop nutrition: Definition of essential nutrients, criteria of essentiality, functional elements, classification of essential nutrients, role of macro and micro nutrients. Nutrient absorption, active and passive absorption of nutrients, forms of plant nutrients absorbed by plants, Combined /un-combined forms. Manures and fertilizers, nutrient use efficiency: Sources of nutrients: Inorganic (fertilizers), organic (manures) and bio-fertilizers; their classification and characteristics, method of preparation and role of organic manures in crop production. Integrated Nutrient Management (INM): Meaning, different approaches and advantages of INM. Green manure- role in crop production: Definition, objectives types of green manuring, desirable characteristics, advantages and limitations of green manuring.

Water management: Water resources of the world, India and the state; Soil Moisture constants: gravitational water, capillary water, hygroscopic water, Soil moisture constants.

Weeds: Definition, Importance and basics of classification of weeds and their control. Agro-climatic zones of India and the state, cropping systems: Factors affecting cropping systems, major cropping patterns and systems in the country. Sustainable crop production: Definition, importance and practices, natural resources and conservation pollution and pollutants, Allelopathy: Meaning and importance in crop production, Growth and development of crops: Definition, Meaning and factors affecting growth and development.

Practical

A visit to Instructional Crop farm and study on field crops, Identification of crops, seeds, fertilizers, pesticides, Crops and cropping systems in different Agro-climatic zones of the state, Study of some preparatory tillage implements, Study of inter tillage implements, Practice of ploughing / puddling, Study and practice of inter cultivation in field crops, Numerical exercises on calculation of seed, plant population and fertilizer requirement, Study of yield contributing characters and yield estimation of crops, Identification of weeds in different crops, Seed

germination and viability test of seed, Practice on time and method of application of manures and fertilizers.

Suggested readings

1. Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
2. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
3. Reddy, S. R. 2008. Principle of Crop Production, Kalyani Publisher, Ludhiana.
4. William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
5. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.

Fundamentals of Soil Science 3 (2+1)

Objective

To impart knowledge on soil genesis, basic soil properties with respect to plant growth

Theory

Soil: Pedological and edaphalogical concepts. Rocks and minerals, weathering, Silicate clays: constitution and properties, sources of charge, ion exchange, cation and anion exchange capacity and base saturation (after buffering capacity), Soil formation, Soil organic matter, Pedogenic processes, Soil colloids: inorganic and organic, Properties of soil colloids and Ion exchange in soils, Soil profile, soil texture, soil structure. Bulk density and particle density, soil consistency, soil temperature, soil air, soil water. Soil reaction and buffering capacity. Soil taxonomy, keys to soil orders. Soils of India.

Practical

Study of general properties of minerals, study of minerals-silicate and non-silicate minerals, study of rocks-igneous, sedimentary and metamorphic rocks; study of a soil profile, collection and processing of soil for analysis, study of soil texture-feel method, mechanical analysis, determination particle density and soil porosity, determination of soil colour, study of soil structure and aggregate analysis, determination of soil moisture, determination of soil moisture constants-field capacity; water holding capacity. Study of infiltration rate of soil, determination of pH and Electrical conductivity of soil.

Suggested readings

1. Introductory Soil Science – By Dilip Kumar Das, Kalyani Publishers
2. Soil Fertility and Nutrient Management – By S. S. Singh, Kalyani Publishers
3. Soil Fertility and Fertilizers – By Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
4. The Nature and Properties of Soils – By Harry O. Buckman and Nyle C.

Fundamentals of Horticulture 3 (2+1)

Objectives

1. To provide knowledge on different branches of horticulture viz. pomology, olericulture, floriculture and landscaping, spices and medicinal plants
2. To provide knowledge on orchard management, propagation methods, cultural operations and nutrient management of horticultural crops
3. To provide knowledge on different physiological aspects of horticultural crops

Theory

Horticulture: Its different branches, importance and scope, Horticulture and botanical classification, soil and climate for horticultural crops. Plant propagation: methods and propagation structures, seed dormancy and seed germination, Merits and demerits of sexual and asexual propagation Stock-scion relationship.

Principles of orchard establishment, principles and methods of training and pruning of fruit crops, Juvenility and flower bud differentiation, unfruitfulness in horticultural crops, pollination, pollinizers and pollinators, fertilization and parthenocarpy, importance of bio regulators in horticultural crops, irrigation and its methods, Fertilizer application in horticultural crops.

Practical

Identification and nomenclature of fruit, Layout of an orchard, pit making and system of planting, Nursery raising techniques of fruit crops, Understanding of plant propagation structures, Propagation through seeds and plant parts, Propagation techniques for horticultural crops, Container, potting mixture, potting and repotting, Training and pruning methods on fruit crops, Preparation of fertilizer mixture and application, Preparation and application of PGR, Layout of different irrigation systems, Maturity studies, harvesting, grading, packaging and storage.

Suggested readings

1. Basics of Horticulture by Jitendra Singh
2. Introduction to Horticulture by N. Kumar
3. Handbook of Horticulture by ICAR

National Cadet Corps (NCC-1), National Service Scheme (NSS-2) 1 (0+1)

National Cadet Corps- As per government guidelines, for getting B and C certificate in NCC, minimum years of requirement is 2 and 3 years along with 1-2 annual camps

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.

- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV; each having one credit load.

The entire four courses should be offered continuously for two years. A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration

- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

Course Title: Introductory Mathematics (Non-gradial) 1 (1+0)

Theory: Algebra: Progressions- Arithmetic, Geometric and Harmonic Progressions. Matrices: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation- Growth rate, Average Cost, and Marginal cost, Marginal Cost, Marginal Revenue. Partial differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form $y = f(x)$ and $y = f(x1, x2)$.

Integral Calculus: Integration -Definite and Indefinite Integrals-Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Semester-II

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir. 1988. How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies: Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems: Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h. Light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management: Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, Prasanthrajan, S., Umesh, M. and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India. (In Press).
5. Prasanthrajan M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008
6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Soil Fertility Management 3 (2+1)

Objective

To provide a comprehensive knowledge of soil fertility, plant nutrition, fertilizers, and nutrient management

Theory

History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of macro and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Introduction and importance of manures and fertilizers. Fertilizer recommendation approaches.

Integrated nutrient management. Chemical fertilizers: classification, composition and properties of major fertilizers, secondary and micronutrient fertilizers, Complex fertilizers, Customised fertilisers, water soluble fertilizers nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions. STCR/RTNM/IPNS, Carbon sequestration and Carbon Trading, Preparation and properties of major manures (FYM, Compost, Vermicompost, Green manuring, Oilcakes).

Practical

Introduction of analytical instruments and their principles, calibration and applications of Coloremetry and flame photometry; Estimation of alkaline hydrolysable N in soils; Estimation of soil extractable P in soils; Estimation of exchangeable K in soils; Estimation of exchangeable Ca and Mg in soils; Estimation of soil extractable S in soils; Estimation of DTPA extractable Zn in soils; Estimation of N in plants; Estimation of P in plants; Estimation of K in plants; Estimation of S in plants.

Suggested readings

1. Introductory Soil Science by Dilip Kumar Das, Kalyani Publishers
2. Soil Fertility and Nutrient Management by S. S. Singh, Kalyani Publishers
3. Soil Fertility and Fertilizers by Samual L. Tisdale, Werner L. Nelson and James D. Beaton, Macmillan Publishing Company, New York
4. The nature and Properties of Soils by Harry O. Buckman and Nyle C.

Fundamentals of Entomology 3(2+1)

Objectives

1. To know the history of entomology, classification of insects and their relationship with other arthropods
2. To study the various morphological characters of class insect and their importance for classification of insects
3. To get an idea about the different physiological systems of insects and their roles in growth and development and communications of insects
4. To study the characteristics of commonly observed insect orders and their economically important families

Theory

History of Entomology in India. Major points related to dominance of Insects in Animal kingdom. Classification of phylum Arthropoda up to classes. Relationship of class Insects with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs. Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors and biotic factors. Categories of pests. Systematics: Taxonomy – importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta up to Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigoniidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

Suggested readings

1. Fundamentals of Ecology - Eugene. P. Odum and Gray W. Barrett
2. Imm's General Text book of Entomology— O.W. Rechards and R.G. Davies
3. Introduction to the study of Insects –D. J. Borror and DeLong's

Livestock and poultry Management 2(1+1)

Objectives

1. Provide basic knowledge to the students about scientific livestock and poultry rearing practices
2. Entrepreneurship development through Livestock/poultry and Agriculture Integrated Farming System

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipment. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production

Suggested Readings

1. A Textbook of Animal Husbandry by G. C Banerjee
2. A text Book of Livestock Production management in Tropic by D. N. Verma

Fundamentals of Plant Pathology 3(2+1)

Objectives

1. To get acquainted with the role of different microorganisms in the development of plant disease
2. To get general concepts and classification of plant diseases
3. To get knowledge of general characteristics of fungi, bacteria, virus, and other microorganisms causing plant diseases
4. To acquaint the students with reproduction in fungi, and bacteria, causing plant diseases
5. To get acquainted with various plant disease management principles and practices

Theory

Introduction to Plant Pathology: Concept of disease in plants; Different terms used in Plant Pathology, History of Plant Pathology with special references to India; Causes of plant disease: Inanimate and animate causes; Classification of plant disease; Parasitism and pathogenesis; Development of disease in plants: Disease Triangle, Disease cycle; Fungi and their morphology, reproduction and classification of fungi; Bacteria: Morphology, reproduction classification of phytopathogenic bacteria; Other plant pathogens: Mollicutes; Flagellant protozoa; FVB; Green

algae and parasitic higher plants; Viruses and viroids, virus transmission; Principles of Plant disease management: Disease management with chemicals, Host resistance, cultural and biological method of Integrated Disease Management (IDM).

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Study of different plant disease symptoms; Microscopic examination of general structure of fungi; Simple staining of bacteria: Direct and indirect staining, Gram staining of bacteria; Microscopic examination of fungal diseased specimen; Microscopic examination of bacterial diseased specimen; Preparation of culture media; Isolation of plant pathogens: Fungi, bacteria and viruses; Purification of plant pathogens; Study on plant disease diagnosis: Koch's Postulates, Characteristics, formulation, methods of application and calculation on fungicides.

Suggested readings

1. Agrios, G.N. 2010. Plant Pathology. Acad. Press.
2. Alexopoulos, Mims and Blackwel. Introductory Mycology.
3. Dhingra, O.D. and Sinclair, J.B. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo.
4. Gibbs, A. and Harrison, B. 1976. Plant Virology - The Principles. Edward Arnold, London
5. Goto, M. 1990. Fundamentals of Plant Bacteriology. Academic Press, New York.
6. Hull R. 2002. Mathew's Plant Virology. 4th edn. Academic Press, New York.
7. Kamat, M. N. Introductory Plant Pathology. Prakash Pub, Jaipur.
8. Mehrotra, R.S. and Aggarwal, A. 2007. Plant Pathology. 7th edn. Tata Mc Graw Hill Publ. Co. Ltd.
9. Nene, Y.L. and Thapliyal, P.N. 1993. Fungicides in Plant Disease Control. 3rd Ed. Oxford & IBH, New Delhi.
10. Pathak, V. N. Essentials of Plant Pathology. Prakash Pub., Jaipur
11. Rajeev, K. and Mukherjee, R.C. 1996. Role of Plant Quarantine in IPM. Aditya Books.
12. Rhower, G.G. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd edn. Vol. II. (Ed. David Pimental). CRC Press.
13. Singh R.S. 2008. Plant Diseases. 8 th Ed. Oxford & IBH. Pub. Co.
14. Singh R.S. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.
15. Verma, J.P. 1998. The Bacteria. Malhotra Publ. House, New Delhi.
16. Vyas SC. 1993. Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

National Cadet Corps (NCC-II) 1 (0+1)

- Arms Drill-Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/ long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.

- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1(0+1)

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Semester III

Entrepreneurship Development and Business Communication 3 (2+1)

Objective

1. To provide student an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning: spotting of opportunity, scanning of environment identification of product / service: starting a project; factors influencing sensing the opportunities. Infrastructure and support systems: good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management: product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management: raw material costing, inventory control. Personal management: manpower planning, labour turn over, wages / salaries. Financial management /accounting: funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management: market, types, marketing assistance, market strategies. Crisis management: raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath, P.M. 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai, V. 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka, S.S. 1999. Entrepreneurial Development. S. Chand & Co.
6. Mehra, P. 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey, M. and Tewari, D. 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
9. Singhal, R.K. 2013, Entrepreneurship Development & Management, Katson Books.
10. Tripathi, P.C. and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill.

11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i) To make the students aware about Physical Education, First Aid and Yoga Practices

ii) To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Principles of Genetics 3 (2+1)

Objective

To make the students acquainted with both principles and practices in the areas of classical genetics, modern genetics, quantitative genetics and cytogenetics.

Theory

Pre and post Mendelian concepts of heredity, Mendelian principles of heredity, Study of model organisms (Drosophila, Arabidopsis, Garden pea, *E. coli*, and mice), Architecture of chromosomes, chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere, special types of chromosomes, Chromosomal theory of inheritance- cell cycle and cell division-mitosis and meiosis. Probabilit and Chi-square. Types of DNA and RNA, Dominance relationships, Epistatic interactions with example, Introduction and definition of cytology, genetics and cytogenetics and their interrelation.

Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanism, chromosome mapping, Structural and numerical variations in chromosomes and their implications, Use of haploids, dihaploids and double haploids in Genetics, Mutation, classification, Methods of inducing mutations, mutagenic agents and induction of mutation. Qualitative and quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance, Nature, structure and replication of genetic material, Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation.

Practical

Study of microscope, Study of cell structure, Mitosis and Meiosis cell division, Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and chi-square test, Determination of linkage and croo-over analysis (through two point test cross data), Study on sex linked inheritance in Drosophila. Study on models on DNA and RNA structures.

Suggested readings

1. Fundamentals of Genetics: B. D. Singh
2. Genetics: M. W. Strickberger.
3. Principles of Genetics: Gardner, Simmons and Snustad.
4. Principles of Genetics: Sinnott, Dunn and Dobzhansky

Course Title: Crop Production Technology-I (*Kharif* crops) 3 (1+2*)

Objectives

1. To impart basic and fundamental knowledge on principles and practices of kharif crop production
2. To impart knowledge and skill on scientific crop production and management

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals- rice, maize, sorghum, pearl millet, finger millet and other minor millets, pulses- pigeonpea, mungbean and urdbean; oilseeds- groundnut, soybean, sesame, castor; fibre crops- cotton and jute; forage crops- sorghum, cowpea, cluster bean, maize, guinea and napier.

Practical

Rice nursery preparation, transplanting of rice, sowing of soybean, pigeon pea and mungbean, maize, groundnut and cotton, effect of seed size on germination and seedling vigour of *Kharif* crops, effect of sowing depth on germination of *Kharif* crops, identification of weeds in *Kharif* crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of *Kharif* crops, study of crop varieties and important agronomic experiments at experiential farm, recording biometric observations, Study of forage experiments, morphological description of *Kharif* crops, silage and hay making, visit to research centres of related crops.

***Practical Crop Production- One (1) credit from practical of the course is allotted for Practical Crop Production of selected *kharif* crops covered under this course.**

Suggested Readings

1. B. Gurarajan, R. Balasubramanian and V. Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
4. S.R. Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
5. S.S. Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
6. UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.
7. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production. South Asian Publishers, New Delhi.

Production Technology of Fruit and Plantation Crops 2 (1+1)

Objectives

1. To educate about the different forms of classification of fruit crops
2. To educate about the origin, area, climate, soil, improved varieties and cultivation practices of fruit and plantation crops
3. To educate about the physiological disorders of fruit crops, palms and plantation crops

Theory

Production status of fruit and plantation crops: Importance and scope of fruit and plantation crop industry in India; nutritional value of fruit crops; classification of fruit

crops; area, production, productivity and export potential of fruit and plantation crops. Crop production techniques in tropical, sub-tropical and temperate fruit crops: Climate and soil requirements, varieties, propagation and use of rootstocks, planting density and systems of planting: High density and ultra-high density planting, cropping systems, after care – training and pruning; water, nutrient and weed management, fertigation, special horticultural techniques, plant growth regulation, important disorders, maturity indices and harvest, value addition.

Fruit crops: mango, banana, papaya, guava, sapota, citrus, grape, litchi, pineapple, pomegranate, apple, pear, peach, strawberry, nut crops Jackfruit and minor fruits- date, ber, apple, plantation crops-coconut, arecanut, cashew, tea, coffee and rubber.

Crop production techniques in palms and plantation crops: Climate and soil requirements, varieties, propagation, nursery management, planting and planting systems, cropping systems, after care, training and pruning for plantation crops, water, nutrient and weed management, intercropping, multi-tier cropping system, mulching, special horticultural practices, maturity indices, harvest and yield, pests and diseases, processing- value addition

Palms: Coconut, Arecanut, Oil palm and Palmyrah, Plantation crops: Tea, Coffee, Cocoa, Cashewnut, Rubber.

Practical

Propagation techniques, selection of planting material, varieties, important cultural practices for mango, banana, papaya, guava, sapota, grapes, Citrus (mandarin and acid lime), pomegranate, jackfruit, preparation and application of PGR's for propagation, Micro propagation, protocol for mass multiplication and hardening of fruit crops, Identification and description of varieties, mother palm and seed nut selection, nursery practices, seedling selection, fertilizers application, nutritional disorders, pests and diseases of Coconut, Arecanut and cocoa, Tea and coffee, Rubber and cashew, Visit to commercial orchard and plantation industries.

Suggested Readings

1. Banday, F.A. and Sharma, M.K.2010 Advances in temperate fruit production. Kalyani Publishers, Ludhiana
2. Bose, T.K., S.K. Mitra and D. Sanyal 2001. Fruits: Tropical and Subtropical (2 volumes) Naya Udyog, Calcutta.
3. Bose, T.K., S.K. Mitra, A.A. Farooqi and M.K. Sadhu (Eds). 1999. Tropical Horticulture Vol.1. Naya Prokash, Calcutta.
4. Chadha, K.L. 2001. Handbook of Horticulture. ICAR, Delhi
5. Chadha, T.R. 2001 Textbook of temperate fruits. ICAR, New Delhi
6. Chattopadhyay, T.K. 2001. A Text Book on Pomology (4 volumes). Kalyani Publishers, Ludhiana.
7. Chattopadhyay. 1998. A textbook on pomology (sub-tropical fruits) vol.III. Published by M/s. Kalyani publishers, Ludhiana, New Delhi, Noida. UP.
8. Chudawat, B. S.1990. Arid fruit culture Oxford &IBH, New Delhi

9. Das, B.C. and Das S.N. Cultivation of minor fruits. Kalyani Publishers, Ludhiana
10. David Jackson and N.E. Laone, 1999. Subtropical and temperate fruit production. CABI publications
11. H.P. Singh and M.M. Mustafa 2009. Banana-new innovations Westville publishing House, New Delhi
12. Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, Tamil Nadu.
13. Mitra, S.K., T.K. Bose and D.S. Rathore. 1991. Temperate fruits. Horticulture and allied Publishers, Calcutta.
14. Pal, J.S. 1997. Fruit Growing. Kalyani Publishers, New Delhi.
15. Radha, T. and Mathew, L.2007. Fruit crops. New India publishing Agency
16. Rajput, CBS and Srihari babu, R.1985. Citriculture, Kalyani Publishers, Ludhiana
17. Sadhu, M.K. and P.K. Chattopadhyay. 2001. Introductory Fruit Crops. Naya Prokash, Calcutta.
18. Singh, S.P. 2004. Commercial Fruits. Kalyani Publishers, Ludhiana
19. Symmonds. 1996. Banana, II Edn.Longman, London
20. Veeraragavathatham, D., Jawaharlal, M., Jeeva, S., Rabindran, R and Umapathy, G. 2004 (2nd edition). Scientific fruit culture. Published by M/s. Suri associates, 1362/4, Velraj Vihar Complex, Thadagam Road, Coimbatore- 2
21. W.S. Dhillon. 2013. Fruit production in India. Narendra publishing House, New Delhi
22. Kavino, M, V. Jegadeeswari, R. M. Vijayakumar and S. Balkrishnan. 2018. Production Technology of Fruits and Plantation Crops by Narendra Publishing House.
23. Kumar, N.J. B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to spices, Plantation crops and Aromatic plants. Oxford & IBH, New Delhi.
24. Nair. 1979. Cashew, CPCRI, Kerela
25. Sharma, A., Kumar, P., Tripathi, V.K. 2024. Production Technology of Fruits and Plantation Crops. Elite Publishing House
26. Thampan, P.K.1981. Handbook of coconut palm. Oxford &IBH, New Delhi.
27. Thompson, P.K.1980. Coconut. Oxford &IBH, New Delhi
28. V. Ponnuswami, M. Kumar; S. Ramesh Kumar and C. Krishnamoorthy 2015. Fruit and Plantation Crops Narendra Publishing House.

Fundamentals of Extension Education 2 (1+1)

Objectives

1. State the importance of extension education in agriculture
2. Familiarize with the different types of agriculture and rural development programs launched by govt. of India
3. Classify the types of extension teaching methods
4. Elaborate the importance and different models of communication
5. Explain the process and stages of adoption along with adopters' categories

Theory

Education: Meaning, definition and Types; Extension Education: meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning: Meaning, Process, Principles and Steps in Programme Development. Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); Reorganised Extension System (T&V system) various extension/ agriculture development programs launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP, etc.). Social Justice and poverty alleviation programme: ITDA, IRDP/SGSY/NRLM. Women Development Programme: RMK, MSY etc. New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc., Attributes of Innovation, DWCRA, Commodity Interest Groups (CIGs)., Farmers Producer Group (FPG).

Rural Development: concept, meaning, definition; various rural development programs launched by Govt. of India. Community Development: meaning, definition, concept and principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; Method of identification of Rural Leader. Extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programs; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; Identification of rural leaders in village situation; preparation and use of AV aids, preparation of extension literature (leaflet, booklet, folder, pamphlet news stories and success stories); Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA/PRI and other development departments at district level; visit to NGO/FO/FPO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media: visit to community radio and television studio for understanding the process of programme production; script writing, writing for print and electronic media, developing script for radio and television.

Suggested readings

1. Adivi Reddy, A. 2001. Extension Education, Sree Lakshmi press, Bapatla.
2. Dahama, O. P. and Bhatnagar, O.P. 1998. Education and Communication for Development, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
3. Jalihal, K. A. and Veerabhadraiah, V. 2007. Fundamentals of Extension Education and Management in Extension, Concept publishing company, New Delhi.

4. MuthaiahManoraharan, P. and Arunachalam, R., Agricultural Extension, Himalaya Publishing House (Mumbai).
5. Sagar Mondal and Ray, G. L., Text Book on Rural Development, Entrepreneurship and Communication Skills, Kalyani Publications.
6. Rathore, O. S. et al. 2012. Handbook of Extension Education, Agrotech Publishing Academy, Udaipur.
7. Dudhani, C.M., Hirevenkatgoudar, L.V., Manjunath, L. Hanchinal, S.N. and Patil, S.L. 2004. Extension Teaching Methods and Communication Technology, UAS, Dharwad.
8. Sandhu, A.S. 1993. Text book on Agricultural Communication: Process and Methods. Oxford and IBH Publishing Pvt. Ltd, New Delhi.
9. Singh, A.K., Lakhan Singh, R. and Roy Burman. 2006. Dimensions of Agricultural Extension. Aman Publishing House, Meerut

Fundamentals of Nematology 2(1+1)

Objectives

1. To impart knowledge on history, economic importance of plant parasitic nematodes, morphology, biology, host parasitic relationship of nematodes.
2. To impart knowledge on nematode pests of different crops of national and local importance and their management.

Theory

Introduction: History of phytonematology, habitat and diversity, economic importance of nematodes. General characteristics of plant parasitic nematodes. Nematode: definition, general morphology and biology. Classification of nematodes up to family level with emphasis on groups containing economically important genera. Classification of nematodes on the basis of feeding/ parasitic habit. Symptomatology, role of nematodes in disease development, Interaction between plant parasitic nematodes and disease-causing fungi, bacteria and viruses. Nematode pests of crops: Rice, wheat, vegetables, pulses, oilseed and fiber crops, citrus and banana, tea, coffee and coconut. Different methods of nematode management: Cultural methods, physical; methods, Biological methods, Chemical methods, Plant Quarantine, Plant resistance and INM.

Practical

Sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following Cobb's sieving and decanting technique, Baermann funnel technique, Picking and counting of plant parasitic nematode. Identification of economically important plant nematodes up to generic level with the help of keys and description: Meloidogyne, Pratylenchus; Heterodera, Tylenchulus, Xiphinema, and Helicotylenchus etc. Study of symptoms caused by important nematode pests of cereals, vegetables, pulses, plantation crops etc. Methods of application of nematicides and organic amendments.

Suggested readings

1. Economic Nematology-Edited by J.M. Webster
2. Plant Parasitic Nematodes (Vol-1) by Zukerman, Mai, Rohde

3. Plant Parasitic Nematodes of India: Problems and Progress by - Gopal Swarup, D. R. Dasgupta, P. K. Koshy.
4. Text book on Introductory Plant Nematology -R.K. Walia and H.K. Bajaj.

Principles and Practices of Natural Farming 2 (1+1)

Objectives

1. To provide comprehensive understanding and knowledge to students about natural farming.
2. To teach students the concept, need and principles of native ecology-based production under natural farming.
3. To impart practical knowledge of natural farming and related agricultural practices in Indian and global environmental and economic perspectives.

Theory

Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming in view of climate change, soil health, water use carbon sequestration, biodiversity conservation, food security and nutritional security, and sustainable development goals (SDGs), Concept of natural farming; Definition of natural farming; Objective of natural farming, Essential characteristics and Principles of natural farming; Scope and importance of natural farming. Main Pillars of natural farming; Methods/ types/schools of natural farming. Characteristics and design of a natural farm, Concept of ecological balance, ecological engineering and community responsibility in natural versus other farming systems, Introduction to concept of ecological, water, carbon and nitrogen foot prints, Concept and evaluation of ecosystem services, integration of crops, trees and animals, cropping system approaches, Biodiversity, indigenous seed production, farm waste recycling, water conservation and renewable energy use approaches on a natural farm, Rearing practices for animals under natural farming, Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Mechanization in natural farming, Processing, labelling, economic considerations and viability, certification and standards in natural farming, marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of natural farming and chemical free agriculture, Case studies and success stories in natural farming and chemical free traditional farming, Entrepreneurship opportunities in natural farming.

Practical

Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming principles at the farm; Indigenous technical knowledge (ITK) for seed, tillage, water, nutrient, insect-pest, disease and weed management; On-farm inputs preparation methods and protocols, Studies in green manuring in-situ and green leaf manuring, Studies on different types of botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient, insect and pest and disease management; Weed management practices in natural farming; Techniques of Indigenous seed production- storage and marketing, Partial and complete nutrient and financial budgeting in natural farming; farming; Evaluation of ecosystem services in natural farming (Crop, Field and System).

Suggested readings

1. Ayachit, S.M. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation 4: 205.
2. Boeringa, R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
4. Ecological Farming -The seven principles of a food system that has people at its heart. May 2015, Greenpeace.
5. Ecological Farming, The Seven principles of a food system that has people at its heart. May 2015, Greenpeace
6. FAO. 2018. The 10 elements of agro-ecology: guiding the transition to sustainable food and agricultural system.https://www.fao.org/3/i9037en/i9037en.pdf Agro ecosystem Analysis for Research and Development Gordon R. Conway.1985.
7. Fukuoka, M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
8. Fukuoka, M. 1985. The Natural Way of Farming: The Theory and Practice of Green Philosophy. Japan Publications, Tokyo, 280 pp.
9. Hill S.B and Ott. P. (Eeds.). 1982. Basic Techniques in Ecological Farming Berkhauser Verlag, Basel, Germany, 366 pp.
10. Hill, S.B. and Ott, P. (Eeds.). 1982. Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
11. HLPE. 2019. Agroeeological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and nutrition of the Committee on World Food Security, Rome. https://fao.org/3/ea5602en/ea5602en.pdf.
12. INFRC. 1988. Guidelines for Nature Farming Techniques. Atami, Japan. 38 pp.
13. Khurana, A. and Kumar, V. 2020. State of Organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
14. Malhotra R. and S.D. Babaji. 2020. Sanskrit Non Translatable- The importance of Sanskritizing English. Amaryllis, New Delhi India.
15. Nalini, S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telengana), India. 94pp.
16. Nalini, S. 1999. Krishi-Parashara (Agriculture by Parashara) by Parashara. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
17. Nalini, S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 64p

18. Natural Asset Farming: Creating Productive and Biodiverse Farms by David B. Lindenmayer, Suzannah M. Macbeth, et al. (2022)
19. Natural Farming Techniques: Farming without tilling by Prathapan Paramu (2021)
20. Plenty for All: Natural Farming A to Z Prayog Pariwar Methodology by Prof. Shripad A. Dabholkar and Prayog Pariwar Prayog Pariwar (2021)
21. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, Ottho Heldringstraat.
22. Shamasastry, R. 1915. Kautilya's Arthashastra.
23. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016)
24. U. K. Behera. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.
25. कमलागतप्राकृततककृतिः आचार्यदेवव्रत, pp 1-166.

Semester IV

Agricultural Informatics and Artificial Intelligence (AI) 3(2+1)

Objective

- To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
- To provide basic knowledge of computer with applications in Agriculture
- To make students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts. Concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions. Preparation of contingent crop-

planning and crop calendars using IT tools. Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management .Use of MS-Word and MS Power-point for creating, editing and presenting a scientific documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/VR demonstration, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

Production Technology of Vegetables and Spices 2(1+1)

Objectives

1. To educate about the different forms of classification of vegetables
2. To educate about the origin, area, climate, soil, improved varieties and cultivation practices of vegetables and spices
3. To educate about the physiological disorders of vegetables and spices

Theory

Importance of vegetables and spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such

as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of important vegetable and spices (tomato, okra, brinjal, chili, capsicum, cucumber, bitter gourd , bottle gourd, sweet potato, cassava and moringa, pumpkin, French bean, peas; cole crops such as cabbage, cauliflower, knol-khol; bulb crops such as onion, garlic; root crops such as carrot, radish, beetroot; tuber crops such as potato; leafy vegetables such as amaranth, palak, perennial vegetables, spice crops like turmeric, zinger, garlic, coriander, cumin, black pepper, cardamom, fenugreek, fennel, clove, nutmeg, cinnamon, curry leaf, tamarind and herbal spices).

Practical

Identification of vegetables and spice crops and their seeds. Description of varieties. Propagation methods - rapid multiplication techniques - seed collection and extraction. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables and spices. Fertilizers applications. Harvesting and post-harvest practices, Economics of vegetables and spices cultivation**,** visit to spice gardens.

Suggested readings

1. Olericulture, Fundamentals of Vegetable Production (Vol.1) by K.P. Singh, Anant Bahadur
2. Vegetable crops by J. Kabir, T.K. Bose, M.G. Som
3. Vegetable crops (Production technology, Vol II) by M.S. Fagaria, B.R. Choudhury, R.S. Dhaka

Principles of Agricultural Economics and Farm Management 2(2+0)

Objectives

1. To aware the students about broad areas covered under agricultural Economics and farm management
2. To impart knowledge on judicious use of resources for optimum production

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro- and macro-economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. Demand: meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. Laws of returns: Law of variable proportions and law of returns to scale. Cost: Cost concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. National income: Meaning and importance,

circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programs on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation. Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning. Forms of business organizations, international trade and balance of payments. GST and its implication on Indian economy.

Suggested Readings

1. Johl, S.S. and T.R Kapur. 2009. Fundamentals of Farm Business Management. Kalyani Publishers
2. S. Subha Reddy, P. Raghu Ram, T.V. Neelakanta and I. Bhvani Devi .2004. Agricultural Economics. Oxford & IBH publishing Co. Pvt. Ltd

Crop Production Technology-II (*Rabi* Crops) 3(1+2)

Objectives

1. To impart basic and fundamental knowledge on principles and practices of *rabi* crop production.
2. To impart knowledge and skill on scientific crop production and management.

Theory: Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops. Cereals- wheat and barley. Pulses- chickpea, lentil, peas. *Rabi* redgram and, rajmash. Oilseed- rapeseed, mustard, sunflower, safflower; and linseed. Sugar crops-sugarcane and sugar beet. Medicinal and aromatic crops- mentha, lemon grass and citronella. Forage crops –barseem, lucerne and oat; potato, quinoa, tobacco.

Practical: Sowing methods of wheat and sugarcane; identification of weeds in *rabi* season crops; study of morphological characteristics of *rabi* crops; study of yield contributing characters of *rabi* season crops; yield and juice quality analysis of sugarcane; study of important agronomic experiments of *rabi* crops at experimental farms; study of *rabi* forage experiments; oil extraction of medicinal crops; visit to research stations of related crops.

* **Practical Crop Production-One (1) credit from practical of the course is allotted for Practical Crop Production of selected *rabi* crops covered under this course.**

Suggested Readings

1. B. Gurarajan, R. Balasubramanian and V. Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
2. Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
4. Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.

5. S.R. Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
6. S.S. Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
7. Rajendra Prasad. 2002. Text Book of Field Crops Production, ICAR, New Delhi.
8. Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
9. Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi.
10. UAS, Bangalore. 2011. Package of Practice. UAS, Bengaluru.

Farm Machinery and Power 2(1+1)

Objectives

To enable the students to understand the need of farm power, basic principles and parts of IC engine, different tillage, sowing, intercultural, plant protection equipment, working principles of threshers, harvesting of field and horticultural crops.

Theory

Status of Farm Power in India; Sources of Farm Power, I.C. engines, working principles of I C engines; comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine, I.C. engine terminology and solved problems; Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; Familiarization with Power transmission system : clutch; gear box, differential and final drive of a tractor; Tractor types; Cost analysis of tractor power and attached implement; Criteria for selection of tractor and machine implements. Familiarization with Primary and Secondary Tillage implement; Implement for hill agriculture; implement for intercultural operations; Familiarization with sowing and planting equipment; calibration of a seed drill and solved examples; Familiarization with Plant Protection equipment; Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine; Familiarization with clutch, transmission, differential and final drive of a tractor; Familiarization with lubrication and fuel supply system of engine; Familiarization with brake, steering, hydraulic control system of engine; Learning of tractor driving; Familiarization with operation of power tiller; Implements for hill agriculture; Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow; Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter; Familiarization with different types of sprayers and dusters; Familiarization with different inter-cultivation equipment; Familiarization with harvesting and threshing machinery; Calculation of power requirement for different implements.

Suggested readings

1. Jagdiswar Sahay – Elements of Agricultural Engineering
2. Jain, S.C. and C.R. Rai-Farm Tractor and maintenance and repair. Standard Publishers, 1705-B, Naisarak. Delhi- 110006

3. Ojha, T.P. and A.M. Michael, A.M. Principles of Agricultural Engineering. Vol.I. Jain brothers, 16/893, East Park Road, Karol Bagh, New Delhi -110005
4. Surendra Singh- Farm machinery –Principles and applications, ICAR, New Delhi

Water Management 2 (1+1)

Objectives

1. To study the important properties of soil affecting water availability to crops and water requirement for optimum growth and development
2. To study different methods of irrigation and water management practices of both field and horticultural crops and drainage.
3. To study the soil moisture conservation practices including management of rain water, watershed and command areas.

Theory

Irrigation: definition and objectives; Importance: Function of water for plant growth, water resources and irrigation development for different crops in India; Soil plant water relationships; Available and unavailable soil moisture, distribution of soil moisture, water budgeting, rooting characteristics, moisture extraction pattern, effect of moisture stress on crop growth. Methods of soil moisture estimation, evapotranspiration and crop water requirement; effective rainfall, different approaches of scheduling of irrigation; Methods of irrigation: surface and sub-surface, pressurized methods, viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water; Layout of different irrigation systems, Irrigation efficiency and water use efficiency, conjunctive use of water, irrigation water quality and its management. Water management of different crops (rice, wheat, maize, groundnut, sugarcane, mango, banana and tomato); quality of irrigation water, irrigation management practices for different soils and crops, drip, sprinkler. Layout of underground pipeline system, Irrigation automation, Artificial Intelligence and climate-based irrigation practices and its management.

Practical

Determination of bulk density by field method; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water by using water measuring devices viz., flumes, weirs, notches, orifices; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; Visit to farmers' field and cost estimation of drip irrigation system; Demonstration of filter cleaning, fertigation, injection and flushing of laterals; layout for different methods of irrigation, Erection and operation of sprinkler irrigation system; Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability; Visit to irrigation research centre/ station and visit to command area.

Suggested Readings

3. 1. Rao, Y.P. and Bhaskar, S.R. Irrigation technology. Theory and practice. Agrotech publishing Academy, Udaipur.

2. Dilipkumar Mujmdar. Irrigation water management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
3. S.V. Patil &Rajakumar, G. R., Water Management in Agriculture and Horticultural Crops. Satish serial publishing House, Delhi.
4. Carr M. K. V. and Elias Fereres. Advances in Irrigation Agronomy. Cambridge University Press.
5. Michael, A.M. Irrigation Theory and practice. Vikas publishing house Pvt, Ltd.

Problematic Soils and their management 2 (1 + 1)

Objectives

1. To acquaint the students about various problem soils like degraded soils, acid soils, saline soils, alkali soils, eroded soils, submerged soils, polluted soils. Also to impart knowledge about remote sensing, GIS, Multipurpose tree and Land capability classification
2. To give hands on training about estimation of various soil and water quality parameters associated with problem soils.

Theory

Soil quality and health, Distribution of Waste land and problem soils in India, Categorization of Problem soils based on properties. Reclamation and management of Acid soils, Saline, Sodic soils, Acid Sulphate soils, Eroded and Compacted soils, polluted soils. Contaminated soils (Pesticide contamination, Heavy metal contamination), Mined soils (Coal mined, Oil mined), Management of Riverine soils, Waterlogged soils, Irrigation water – quality and standards, utilization of saline water in agriculture. Use of Remote sensing and GIS in diagnosis and management of problem soils. Irrigation and water quality. Multipurpose tree (MPT) species, bio remediation through MPTs of soils, land capability and classification, land suitability classification.

Practical

Determination of pHs and EC of saturation extract of problematic soil. Determination of redox potential in soil, Estimation of water soluble and exchangeable cations in soil and computation of SAR and ESP and characterization of problematic soil. Determination of Gypsum requirement of alkali / sodic soil. Determination of lime requirement of acidic soil. Determination of Quality of irrigation water (pH, EC, Ca, Mg, Na, CO_3, HCO_3, Cl, SAR and RSC), Determination of nitrate (NO_3-) from irrigation water, Determination of dissolved oxygen and free carbon dioxide levels in water samples.

Suggested readings

1. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR, AGROBIOS (India).
2. Brady Nyle C and Ray R Well., 2014. Nature and properties of soils. Pearson Education Inc., New D Delhi.
3. Cirsan J. Paul., 1985,. Principles of Remote Sensing. Longman, New York
4. Indian Society of Soil Science., 2002. Fundamentals of Soil Science. IARI, New Delhi.

5. Osman, Khan Towhid., 2018., Management of Soil Problems. Springer publication
6. Srivastava, V. C., 2002. Management of Problem Soils -Principles and Practices New Delhi

Basics of Plant Breeding 3 (2+1)

Objectives

To acquaint with different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular techniques for breeding new varieties, which are higher yielding, resistant to biotic and abiotic stresses for ensuring food security.

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male-sterility-genetic consequences, cultivar options, Plant genetic resources, its utilization and conservation Domestication, Acclimatization and Introduction. Centres of origin/ diversity, Components of Genetic variation. Heritability and genetic advance. Pre-breeding and Universal Plant Breeder's equation. Genetic basis and breeding methods in self-pollinated crops-mass and pure line selection, hybridization techniques and handling of segregating population. Multiline concept, Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross-pollinated crops, modes of selection. Population movement schemes-Ear to Row method, Modified Ear to Row, recurrent selection schemes. Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops, clonal selection and hybridization. Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding, mutation breeding- methods and uses. Breeding for important biotic and abiotic stresses. Participatory plant breeding. Variety Release and notification. Intellectual Property Rights, Patenting, Plant Breeders and Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops, Study of floral structures of self-pollinated and cross-pollinated crops, Emasculation and hybridization techniques in self and cross pollinated crops, Consequences of inbreeding on genetic structure of resulting populations, Study of male sterility system, Handling of segregating populations, Methods of calculating mean, range, variance, standard deviation, heritability, Designs used in plant breeding experiments, analysis of Randomized Block Design, To work out the mode of pollination in a given crop and extent of natural out-crossing, Prediction of performance of double cross hybrids, Maintenance of breeding records and data collection, Screening tests for biotic and abiotic stresses.

Suggested Readings

1. Principles of Plant Breeding (1st & 2nd Edition) by RW Allard.
2. Plant Breeding: Principles & Practices by JR Sharma.
3. Plant Breeding- B.D. Singh.
4. Principles and Procedures of Plant Breeding - Biotechnical and Conventional Approaches by GS Chahal and SS Gosal.
5. Principles of Plant Genetics and Breeding by George Acquaah.

Semester V

Agricultural Marketing and Trade

3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; Demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; Pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; Marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR; Role of government in agricultural marketing; Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and

price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested readings

1. Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N. 2002. Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005. Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Joginder Singh. 2006. Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali. 2004. Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R. 2005. Export Management, Laxmi Narain Agarwal, Agra.

Introduction to Agro-meteorology 2(1+1)

Objectives

1. To introduce the students to the concept of weather and climate and underlying physical processes occurring in relation to plant and atmosphere
2. To impart the theoretical and practical knowledge of instruments/equipment used for measurement of different weather variables in an agrometeorological observatory
3. To study the meteorological aspects of climate change in agriculture and allied activities

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere: its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Application of Thermal time concept and Crop/Pest weather calendar; Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture; Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave; Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock

production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording, Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law, Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS; Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis, Measurement of soil temperature and computation of soil heat flux, Determination of vapor pressure and relative humidity, Determination of dew point temperature, Measurement of atmospheric pressure and analysis of atmospheric conditions, Measurement of wind speed and wind direction, preparation of windrose, Measurement, tabulation and analysis of rain, Measurement of open pan evaporation and evapotranspiration, Computation of PET and AET, Use of synoptic charts, weather reports, weather forecasting-types and methods, crop weather calendar.

Suggested Readings

1. Agricultural Meteorology by G.S.L.H.V. Prasado Rao
2. Fundamentals of Agrometeorology and Climate Change by G. S. Mahi and P. K. Kingra
3. Introduction to Agrometeorology and Climate Change by Alok Kumar Patra
4. Introduction to Agrometeorology by H. S. Mavi
5. Text Book of Agricultural Meteorology by M. C.Varshneya and P.B. Pillai

Fundamentals of Crop Physiology 3(2+1)

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption; Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Essential and beneficial elements; Passive and active transport of mineral element; Functions of essential elements; Criteria of essentiality of nutrients; Correction measures for nutrient deficiency symptoms; Foliar nutrition and root feeding – significance; Aeroponics Imbibition; Field capacity, permanent wilting point and available soil moisture; Apoplast, symplast and transmembrane, Ascent of sap – theories and mechanism; Soil-plant-atmospheric continuum. Significance of transpiration. Stomatal opening and closing mechanisms. Definition of Cavitation and embolism. Antitranspirants - types and examples. Hydroponics and sand culture. Overview of plant cell - organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment

system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II.

Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O_2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C_3, C_4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C_4 plant: Productivity of C_4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO_2, O_2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration (O_2, temperature, CO_2 etc.). Terminologies / Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight, dry weight, linear dimension, area etc.). Introduction to CGR, RGR, NAR etc. Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photoperiodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 –D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C_3 and C_4 plants.

Suggested readings

1. Devlin's Exercises in Plant Physiology by Robert Devlin, Francis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Mølle and Angus Murphy
3. Plant Physiology by Robert M. Devlin and Francis H. Witham
4. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
5. Plant physiology by Frank B. Salisbury and Cleon W. Ross

Pest management in crops and stored grains 3 (2+1)

Objectives

Diagnosis and management of major insect and non- insect pests of crops in field and storage

Theory

General description on nature and type of damage by different arthropod pests; Scientific name, order, family, host range, distribution, biology and bionomics; Nature of damage and management of major insect pests of various field crops, vegetable crops, fruit crops, plantation crops, ornamental crops, spices and condiments. Structural entomology and important household pests, their nature of damage and management. Factors affecting loss of stored grains. Insect pests, mites, rodents, birds and microorganisms associated with stored grains and their management. Storage structures and methods of grain storage and fundamental principles of stored grains management. Management of non insect pest of mites, snails and slugs, Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides, Biorational pesticides including insect repellents, antifeedants, Use of drones and AI in pest management,

Practical

Field visit, identification of major insect pests and their damage symptoms. Collection and preservation of major insect pests; collection of damage samples, their identification and herbarium preparation. Methods of monitoring of pest incidence *in situ*. Management strategies of insect pests of different crops. Study on structural entomology and household pests. Storage structures and methods of grain storage. Spraying techniques for selected field and horticultural crops. Vertebrate pest management, Mass multiplication of NPV and entomopathogenic nematodes.

Suggested readings

1. A Textbook of Insect Pest and Disease Management, 2021. Somnath Sen, and Mohd. Sameer, S. Kataria & Sons publish.
2. Agricultural Pests of India and South east Asia, A.S. Athwal, Kalyani Publishers.
3. A Textbook of Applied Entomology, K.P. Srivastava and G. S. Dhaliwal, Kalyani Publish.
4. Essentials of Pest Management: Key Information on Pest Identification and its Management, 2022. Prakash Rambhat Thalya and Ravi Chandra
5. Integrated pest Management Concept and Approaches- G.S. Dhaliwal and Ramesh Arora
6. Pest Management: Methods, Applications and Challenges, Tarique Hassan Askary, Agriculture, Agriculture Issues and policies, Books, Nova, Pest Control, Science and Technology,2022

Diseases of Field and Horticultural Crops and their Management 3 (2+1)

Objectives

1. To study the symptoms produced on the host
2. To study the etiology of the diseases

3. To know about the disease cycle of the pathogens during pathogenesis
4. To study the epidemiological factors responsible for disease development
5. To study the management techniques for curbing the major diseases of field and horticultural crops

Theory

Symptoms, etiology, disease cycle, epidemiology and management of major diseases of the following field and horticultural crops: Field crops- Rice (blast, brown spot, sheath blight, false smut, bacterial leaf blight, bacterial leaf streak, tungro, khaira); Wheat (rusts, loose smut, Karnal bunt); Maize (banded leaf and sheath blight, southern and northern blight, downy mildew); Sorghum (smuts, grain mold, anthracnose); Bajra (downy mildew, ergot) and Finger millet (blast, leaf spot); Groundnut (early and late leaf spots, rust, wilt); Soybean (rhizoctonia blight, bacterial spot, seed and seedling rot, mosaic); Grams (Ascochyta blight, wilt, grey mold); Pea (downy mildew, powdery mildew, rust); Black gram and Green gram (web blight, Cercospora leaf spot, anthracnose, yellow mosaic); Sugarcane (red rot, smut, grassy shoot, ratoon stunting, PokahBoeng); Mustard (Alternaria blight, white rust, downy mildew, sclerotinia stem rot) and Sunflower (sclerotinia stem rot, Alternaria blight); Cotton (anthracnose, vascular wilts, black arm). Horticultural crops: Citrus (canker, gummosis) and Guava (wilt, anthracnose); Banana (sigatoka, Panama wilt, bacterial wilt, bunchy top); Papaya (foot rot, leaf curl, mosaic) and Pomegranate (bacterial blight); Apple (scab, powdery mildew, fire blight, crown gall) and Peach (leaf curl); Grapevine (downy mildew, powdery mildew, anthracnose) and Strawberry (leaf spot); Coconut (bud rot, Ganoderma wilt), Tea (blister blight) and Coffee (rust); Mango (anthracnose, malformation, bacterial blight, powdery mildew); Potato (early and late blight, black scurf, leaf roll, mosaic) and Tomato (damping off, wilt, early and late blight, leaf curl, mosaic); Brinjal (phomopsis blight and fruit rot, sclerotinia blight) and Chilli (anthracnose and fruit rot, wilt, leaf curl); Cucurbits (powdery and downy mildew, wilts) and Cruciferous vegetables (Alternaria leaf spot, black rot, cauliflower mosaic); Beans (anthracnose, bacterial blight) and Okra (yellow vein mosaic); Ginger (soft rot), Turmeric (leaf Spot) and Coriander (stem gall); Rose (dieback, powdery mildew, black leaf spot) and Marigold (botrytis blight, leaf spots).

Practical

To study the symptoms of different diseases of field and horticultural crops: Blast and brown spot of rice, sheath blight and bacterial leaf blight of rice, downy mildew and powdery of cucurbits, rhizoctonia and Cercospora leaf spot of green gram / black gram, Alternaria blight and downy mildew of mustard, early blight of late blight of potato and tomato, Phomopsis blight of brinjal, powdery mildew and rust of pea, stem gall of coriander, anthracnose and fruit rot of chilli, taphrina leaf spot of turmeric, red rot of sugarcane, acquaintance with fungicides, antibiotics and biopesticides and their use in management of diseases of horticultural crops. Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory.

Field visit for the diagnosis of field problems, Collection and preservation of plant diseased specimens for herbarium.

Suggested Readings

1. Integrated Plant Disease Management By R.C. Sharma
2. Plant Diseases By R.S. Singh
3. Plant Disease Management: Principles and Practices By Hriday Chaube
4. Plant Pathology By G.N. Agrios

Crop Improvement (*kharif* crops) – I 2(1+1)

Objectives

1. To provide knowledge about Self-pollinated and cross pollinated *Kharif* crops
2. To learn about origin and distribution of *Kharif* crops
3. To design breeding objectives of major *kharif* crops
4. To impart information on different crop varieties for *Kharif* season

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops of *kharif* season; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in maize, rice, sorghum, pearl millet and pigeopea etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. rice, jute, maize, sorghum, pearl millet, ragi, pigeopea, urdbean, mungbean, soybean, groundnut, sesame, castor, cotton, cowpea, tabacco, brinjal, okra and cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seed production in *kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

Suggested Readings

1. Breeding field crops -I by V.L. Chopra
2. Genetic improvement of field crops by C.B. Singh and D. Khare
3. Genetics and Breeding of Pulse crops by D.P. Singh
4. Vegetable breeding – Principles and Practices by Hari Har Ram
5. Breeding field crops by D.A. Sleper and J.M. Poehlman
6. Plant Breeding –theory and practice by S.K. Gupta

7. Breeding Asian field crops by J.M. Poehlman and D.N. Barthakur
8. Practical manuals on Crop Improvement I (*Kharif* crops) by Rajendra Kumar Yadav

Weed Management 2 (1+1)

Objectives

1. To teach students about principles of weed science
2. To impart practical knowledge of weed management in field and horticultural crops

Theory

Introduction to weeds, characteristics of weeds, their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds, crop-weed completion, factors of competition, factors affecting growth and development. Studies on weed seed bank, weed shifts. Concepts of weed management: physical, cultural, chemical and biological; principles and methods, integrated weed management. Implements for weed control, robotic weed control, weed management in organic/ natural farming. Herbicide classification and properties of important herbicides, concept of adjuvants, surfactants, herbicide formulation and their use, Nano herbicides, precision weed management; Mode of action of herbicides and selectivity phenomenon. Concept of herbicide mixture and utility in agriculture, Herbicide compatibility with agro-chemicals and their application, Herbicide resistance and its management. Weed management in different field and horticultural crops; aquatic weed management, weed management in cropping systems.

Practical

Techniques of weed preservation, weed identification and losses caused by weeds. Biology of important weeds. Study weeds in different situations, Study of herbicide formulations and mixture of herbicide. Study methods of herbicide application, Herbicide application equipment-their parts, use, maintenance and calibration. Weed control implements, Calculation of herbicide doses and requirement, weed control efficiency and weed index, Phytotoxicity of herbicides, Weed management in fallow lands, Management of problem and parasitic weeds.

Suggested Readings

1. Crafts, A.S. and Robbins, W.W. 1973. Weed Control. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Gupta, O.P. 1984. Scientific Weed Management. Today and Tomorrow Printers and Publishers, New Delhi.
3. Gupta, O.P. 2015. Modern Weed Management. Agro Bios (India), Jodhpur.
4. Naidu, V.S.G.R. Handbook of Weed Identification. Directorate of Weed Research, Jabalpur.
5. Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G. 2015. Weed management of Horticultural Crops. Agrobios (India), Jodhpur.
6. Ramamoorthy, K. and Subbian, P. Predominant Weed flora in hill –ecosystems. Agrobios (India), Jodhpur.
7. Rao, V.S. 2000. Principles of Weed Science. Oxford & IBH Publishing Co., New Delhi.

8. Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. All About Weed Control. Kalyani Publishers, Ludhiana.
9. Tadulingam, C. and Venkatnarayana, D. 1955. A Handbook of Some South Indian Weeds. Government Press, Madras.
10. Thakur, C. 1977. Weed Science. Metropolitan Book Co. Pvt. Ltd., New Delhi.

Ornamental Crops, MAPs and Landscaping 2(1+1)

Objectives

1. To educate in detail about origin, area, climate, soil, improved varieties production technology of flowers and MAPs
2. To educate about concept, designing principles and components of landscaping
3. To educate about the physiological disorders of commercial flowers
4. To educate about the post-harvest management and value addition in flower crops and MAP

Theory

Production technology of ashwagandha, costus, isabgol and geranium; Production technology of mint, aloe and ocimum, Coleus, Glory lily, Periwinkle etc.; Production technology of plants like lemongrass, citronella, vetiver and palmarosa etc., Importance and scope of ornamental crops; Importance and scope of medicinal and aromatic plants and landscaping; Principles of landscaping; Landscape uses of trees, shrubs and climbers, Production technology of important cut flowers like rose, gerbera and orchids; Production technology of gladiolus, tuberose and lilium; Production technology of chrysanthemum and carnation; Package of practices for loose flowers like marigold and jasmine under open conditions; Brief concept of Home landscaping, Carpet bedding, Topiary, Bonsai, Lawn, flower arrangement, Herbaceous Border, Hedge, Edge etc.; Processing and value addition imp ornamental crops; Processing and value addition of MAPs produce.

Practical

Identification MAPs and Ornamental plants (trees, shrubs, climbers, seasonal flower and house plants). Propagation of MAP, Bed preparation and planting of MAP; Nursery bed preparation and sowing of seasonal flower seeds; Propagation of ornamental plants by terminal/herbaceous cuttings; Propagation of Anthurium and orchids; Propagation of bougainvillea; Planting of gerbera suckers; Gladiolus corms; Establishment and maintenance of lawn; Preparation of flower preservatives and their use in extending the vase life of cut flowers; Training and pruning of ornamental plants and raising of hedge and edge; Planning and layout of garden.

Suggested readings

1. Floriculture in India by G.S. Randhawa and Mukopadhyay
2. Introduction to spices, plantation crops, medicinal and aromatic plants by N. Kumar, Abdul Khadder, P. Rangaswamy, I. Irulappam
3. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia
4. Commercial flowers (Vol 1 and 2) by T.K. Bose.

Introductory Agro forestry 2 (1+1)

Objectives

1. To study Agro forestry as an alternate system of land use
2. To study different types of Agro forestry for soil and water conservation.
3. To study the characteristics of Agro forestry in terms its potential for soil moisture conservation practices

Theory

Agro-forestry: Definition and scope of Agroforestry system, Type of Agroforestry system, potential of Agroforestry in India, Prevailing agroforestry system in India; MPTS- definition, role of MPTS in agroforestry system, its selection for different agroforestry system, MPTS of India, Ecological aspects of Agroforestry system, tree -crop interaction – competition, nutrient recycling; Traditional Agroforestry as a viable choice to conserve Agro biodiversity of India. Management of Agro-forestry system; Role of agroforestry in soil and water conservation; windbreak; Shelterbelt– definition, objectives.; Socio- economic aspects of Agroforestry system; Design and Diagnostic study of agroforetry system; Silviculture: Definition and scope, Propagation of tree species, Regeneration by seed, coppice, root suckers, Transplanting, stump, branch cutting, rhizomes; Nursery bed preparation and management; Cultural practices for bare root and seedling, field handling of nursery stock; Management of tree species; Silviculture of important tree species, choice of species- site factors, root, crown and bole characteristics, phenology, nutritional and water requirement, ground operation, tending, harvesting utility etc. Horticulture and forage crops-based agroforestry models developed by ICAR-IGFRI; Agroforestry models developed by Indian council of Forestry Research and Education.

Practical

Identification of tree species in agro-forestry, Study of tree growth measurement, Study of environmental parameters affecting AF System, Plant propagation methods, Pre-sowing seed treatment, Preparation of nursery bed exercise, practicing propagation techniques for trees, Afforestation method, practical training, pruning, coppicing, pollarding etc. Planting pattern and designs for plantation, natural and artificial regeneration, Design and diagnostic survey of agro-forestry system, Evaluation of agro-forestry system in different agro climatic zones, Exposure Visit to prevailing agroforestry systems of the state and related important institutions, Virtual visit of agroforestry models developed by ICAR-IGFRI, ICFRE.

Suggested readings

1. Nair, P.K. R. 1993. An Introduction to Agroforestry, Kluar Academic Publisher
2. Chundawat D. S. and S.K. Gautham. 2017. Textbook of Agroforestry. Oxford & IBH Publishing, (ISBN: 9788120408326)
3. Parthiban, K. T, N. Krishnakumar and M. Karthick. 2018. Introduction to Forestry, Scientific Publisher, Jodhpur. 350p
4. Divya M. P. and K. T. Parthiban. 2005. A Textbook on Social Forestry and Agroforestry. Satish Serial Publishing, New Delhi (ISBN: 9384988952).

Semester VI

Fundamentals of Agricultural Biotechnology 3(2+1)

Objectives

To familiarize the students with the fundamental principles of biotechnology, various developments in biotechnology and its potential applications

Theory

Introduction to Plant Tissue Culture and Genetic Engineering: History; Cellular tot potency and cytodifferentiation; Callus culture, Single-cell/suspension culture and their applications; Organogenesis and somatic embryogenesis; Somaclonal variation and its use in crop improvement; Embryo rescue technique and its significance in hybrid development; *In vitro* fertilization, ovule culture and its significance in hybrid development; Protoplast isolation, culture and regeneration; Somatic hybridization (somatic hybrids and cybrids) and its application in crop improvement; Anther and pollen culture for haploid production; Development of disease-free (virus free) plants through apical meristem culture; Micropropagation technique for the generation of quality planting material; Synthetic seeds and its applications; National certification and Quality management of TC plants-secondary metabolite production- *in vitro* germplasm conservation.

Introduction to Molecular Biology: DNA structure, structure and function; DNA replication, transcription and translation, RNA, types and function; Structure of prokaryotic and eukaryotic gene; Central dogma of life - DNA replication, transcription, genetic codes-translation and protein synthesis; Lac Operon concept - Nucleic acid hybridization; Polymerase chain reaction- DNA sequencing – Sanger method; PCR and its applications.

Introduction to recombinant DNA technology: DNA modifying enzymes and vectors; plant genetic transformation – physical (Gene gun method), chemical (PEG mediated) and Agrobacterium-mediated gene transfer methods; Transgenic and its importance in crop improvement with successful stories; biosafety. Introduction to various molecular markers: RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement

Practical

Introduction to Plant Tissue Culture Laboratory; Good Laboratory Practices; Media Preparation and sterilization; Glassware sterilization; Micropropagation; Callus induction and culture; Anther culture; Apical meristem culture; Preparation of synthetic seeds; Isolation of plasmid DNA; Quantification of DNA; Agarose Gel Electrophoresis and visualization of plasmid DNA; Restriction digestion of plasmid DNA and agarose gel electrophoresis; Isolation of Plant genomic DNA; PCR amplification of DNA; Gel electrophoresis of amplified DNA; Visit to tissue culture units /biotech labs.

Suggested readings

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani

3. Christou P and Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
4. Lewin B. 2008. Gene IX. Peterson Publications/ Panima. W.H. Freeman & Co.
5. Primrose SB. 2001. Molecular Biotechnology. Panima.

Course Title: Basic and Applied Agricultural Statistics **3(2+1)**

Objectives To provide an idea on statistical concepts of both descriptive and inference Statistics which will be useful to do statistical analysis

Theory

Introduction to Statistics and its Applications in Agriculture. Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams – Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentation of Data – Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency. Requisites for an Ideal Measure of Central Tendency. Different Types of Measure. Arithmetic Mean– Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median- Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode- Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode.

Measures of Dispersion. Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficients of Dispersions. Co-efficient of Variation.

Measures of Skewness and Kurtosis. Definition of Symmetrical Distribution. Definition of Skewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution. Introduction to Probability. Basic Terminologies. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability.

Addition and Multiplication Theorem (without proof). Conditional Probability. Independent Events. Simple Problems based on Probability. Definition of Random Variable. Discrete and Continuous Random Variable. Normal Distribution- Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation. Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients. Tests of Significance. Definition. Null and Alternative Hypothesis. Type I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two

Sample and Paired t-test with Examples. F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data. Calculation of A.M., Median and Mode (Ungrouped and Grouped data). Calculation of S.D. and C.V. (Ungrouped and Grouped data). Correlation and Regression analysis. Application of t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Suggested readings

1. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
2. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
3. Basic Statistics by B. L. Agarwal, New Age International Publishers.
4. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
5. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
6. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.

Crop Improvement (*Rabi* crops)- II 2(1+1)

Objectives:

1. To provide knowledge about self-pollinated and cross-pollinated *rabi* crops
2. To learn about origin and distribution of *rabi* crops
3. To design breeding objectives of major *rabi* crops
4. To impart information on different crop varieties for *rabi* season

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in wheat, oat, chickpea, rapeseed and mustard etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. wheat, oat, rapeseed and mustard, pulses, potato, sugarcane, tomato, chilli, onion

etc. Study of field techniques for seed production and hybrid seed production in rabi crops; Estimation of heterosis, inbreeding depression and heritability; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

Suggested readings

1. Breeding Field Crops -I by V.L. Chopra
2. Genetic Improvement of Field Crops by C.B. Singh and D. Khare
3. Genetics and Breeding of Pulse crops by D.P. Singh
4. Vegetable Breeding – Principles and Practices by Hari Har Ram
5. Breeding Field Crops by D.A. Sleper and J.M. Poehlman
6. Plant Breeding –Theory and practice by S.K. Gupta
7. Breeding Asian field Crops by J.M. Poehlman and D.N. Barthakur
8. Practical Manuals on Crop Improvement I (*Rabi* crops) by Rajendra Kumar Yadav

Renewable energy in Agriculture and Allied Sector 2(1+1)

Objectives

1. To gain the knowledge on different types of materials used in Renewable Energy
2. To understand the importance of Renewable Energy technology and its applications
3. To train the students on the applications of solar thermal technology

Theory

Classification of energy sources, contribution of these of sources in agricultural sector; Familiarization with biomass utilization for biofuel production and their application; Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource; introduction of solar energy, collection and their application; Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application; Introduction of wind energy and their application. Availability of bio mass and their application in different places.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, gasifier, production process of biodiesel, briquetting machine, production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing, solar cooker and solar drying system. To study solar distillation, solar pond and solar wind hybrid system. Field visit to Solar –Wind farm.

Suggested readings

1. C.S. Solanki. 2011. Solar Photovoltaic – Fundamentals, Technologies and Applications. PHI Learning Pvt. Ltd.
2. S. Sukhatme and J. Nayak. 2008. Solar Energy: Principles of Thermal Collection and Storage. Third Edition (Tata McGraw-Hill).

3. V.V.N. Kishore. 2008. Renewable Energy Engineering and Technology: Principles and Practice, Teri, India.

Dryland agriculture/ Rainfed agriculture and watershed management 2(1+1)

Objectives

1. To learn about characteristics and conditions of dryland/rainfed agriculture
2. To gain knowledge about drought and its mitigation
3. To impart knowledge on water harvesting and watershed management

Theory

Dryland/Rainfed agriculture: Introduction, types and characteristics; History of dry land/ rainfed agriculture in India; Problems and prospects of dry land/rainfed agriculture in India; Soil and climatic conditions prevalent in dry land/rainfed areas; Length of Growing Period (LGP) and Soil Moisture Availability (SMA) and its impact on crop and cropping system; Soil and water conservation techniques; Drought: types, effect of water deficit on physio- morphological characteristics of the plants; Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices; Crops and cropping systems in dry land/rainfed areas; Management of crops in dry land/rainfed areas; Contingent crop planning for aberrant weather conditions; Concept, history, objective, principles and components of watershed management, factors affecting watershed management. Log term rainfall analysis in relation to simple mathematical models and forecasting the weather abnormalities; Alternate land use system location; regional and crop specific dryland principles and practices for profitable and sustainable dryland farming and allied enterprises.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Calculation of Length of Growing Period (LGP) and Soil Moisture Availability (SMA) Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country. Effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress including mechanical and agronomic measure. Soil moisture determination under different land situations, Importance of seed priming to mitigate drought. Assessment of meteorological drought. Characterization and delineation of model watershed. Seed treatment, viz., seed hardening and seed priming techniques for all the agricultural crops Field demonstration on soil and moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

Suggested readings

1. A.K. Srivastava and P.K. Tyagi. 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.

2. D. Lenka. 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
3. G.S.L.H.V. Prasad Rao. 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. H.S. Mavi and Graeme J. Tupper. 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
5. H.S. Mavi. 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. H.V. Nanjappa and B.K. Ramachandrappa. 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
7. S.R. Reddy. 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
8. T. Yellamanda Reddy and G.H. Sankara Reddi. 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.

Agricultural Microbiology and Phyto-remediation 2(1+1)

Objectives

1. To get an introduction to microbiology with specific focus on its significance in agriculture science
2. To get acquainted with the bacterial structure and the function of the different bacterial components
3. To get highlights on different fields of microbiology
4. To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation
5. To get a concept of biological control and the role of biopesticides in plant disease management.

Theory

Introduction to Microbiology: Definition, applied areas of Microbiology and Importance of Microbiology. History of Microbiology: Discovery of microorganisms, spontaneous generation theory, Germ theory of diseases, Immunization, fermentation, and origin of life. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, genetic engineering. Soil Microbiology: Nutrient mineralization and transformation, Air Microbiology: Phyllosphere microflora, Phylloplane microflora, microflora of floral parts etc. Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning. Water Microbiology: Types of water, water microorganisms, and microbial analysis of water e.g. coliform test, Purification of water. Industrial Microbiology: Microbial products, Biodegradation, Biogas production, Biodegradable plastics etc. Biological control: Microbial biopesticides for plant disease management Concepts of rhizosphere microbiology- Rhizodeposits -biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiome-residents and their roles. Potential of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability. Bioremediation of polluted soils using microbial mediators. Phytoremediation of polluted soils.

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Microscopic observation of different groups of microorganisms: moulds (Fungi); Direct staining of bacteria by crystal violet; Negative or indirect staining of bacteria by nigrosin; Gram staining of bacteria; Study of phyllosphere and rhizosphere microflora; Measurement of microorganisms; Preparation of culture media; Isolation and purification of rhizospheric microbes; Isolation and purification of N-fixers; Isolation and purification of Nutrient solubilizers; Isolation and purification of Endophytes.

Suggested readings

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
2. Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta
4. Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd., New Delhi – 10014
5. Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment. Fitzgerald Science Press, Inc.
6. Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US

Agricultural Finance and Cooperation 2(1+1)

Objectives

To impart knowledge on issues related to lending to priority sector credit management and financial risk management

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks. Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports. Bank norms – SWOT analysis. Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED. 3 R's, 5 C's and 7 P's of credit. Crop insurance: its scope, significance and limitations and the potential of the newly launched 'Pradhan Mantri Fasal Bima Yojana' (Prime Minister's Crop Insurance

Scheme). Successful cooperative systems in Gujarat (AMUL), Tamil Nadu (Aavin), Karnataka (Nandini), Maharashtra and Punjab.

Practical

Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire first-hand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet – A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal – A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value-added products. Seminar on selected topics. Different types of repayment plans.

Suggested readings

1. Gittinger, J.P. 1982. Economic Analysis of Agricultural Projects**.** The Johns Hopkins Univ. Press.
2. Reddy, S. S. and Ram, P.R. 1996. Agricultural Finance and Management. Oxford & IBH.

Essentials of Plant Biochemistry 3 (2+1)

Objective

To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory

Biochemistry – Introduction and importance, Properties of water, pH and buffer, plant cell and its components. Bio-molecules – Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Vitamins – physiological and metabolic role. Enzymes: General properties; Classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes, use of enzymes. Metabolic energy and its generation – Metabolism – Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. Biosynthetic Pathways – Photosynthesis, Gluconeogenesis, nitrogen fixation, fatty acid and starch formation. Regulation of metabolic pathways. Secondary metabolites, Terpenoids, Alkaloids, Phenolic and their applications in food and pharmaceutical industries.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and starch, Estimation of protein by Kjeldhal method and Lowry's method, Preparation of mineral solution from ash, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Qualitative/quantitative tests of secondary metabolites.

Suggested reading

1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded)
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
4. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.

Fundamentals of Seed Science and Technology 2 (1 + 1)

Objectiv Objectives

1. To impart basic and fundamental knowledge on principles and practices seed science and technology
2. To impart practical skills on scientific seed production and post-harvest quality management

Theory

Introduction to seed technology, definition and importance; Seed quality -definition, characters of good quality seed; Causes of deterioration of varietal purity and assessment of genetic purity, different classes of seed. Foundation and certified seed production of important cereals, pulses and oilseed, field inspection, importance and procedures; Post-harvest seed quality management; seed processing procedures, seed drying; Seed treatment, its importance, method of application and seed packing; seed storage - general principles, stages and factors affecting seed longevity during storage; Seed health management during storage. Seed Certification and legislation; Seed Act and Seed Act enforcement, duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, basics of seed quality testing; New Seed Bill 2019; Seed quality enhancement techniques.

Practical

Seed Structure, Seed sampling, Physical purity, Moisture determination, Germination test, Seed and seedling vigour test, Seed Viability, Genetic purity test: Grow out test, Field inspection, Seed health testing using blotter and agar plate method. Visit to seed production farms, seed testing laboratories and seed processing plant.

Suggested Readings

1. Agarwal, R.L. 1995. Seed Technology (2nd edition). Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, India.
2. Khare, D. and Bhale, M.S. 2019. Seed Technology (2nd revised & enlarged edn), Scientific Publishers, ISBN: 978-81-72338-84-8, New Pali Road, P.O. Box 91, Jodhpur, India
3. Vanangamudi, K. 2014. Seed Technology (An illustrated book), New India Publishing Agency, New Delhi, India.
4. Bhojwani, S.S. and Bhatnagar, S.P. 1999. The Embryology of Angiosperm. Vikas Publ
5. McDonald, M.B. Jr and Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall.

6. Tunwar, N.S. and Singh, S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

Semester VII

S. No	Course title	Total credits
1	5 Elective Courses each of 4 (3+1) credits/Research Project with related courses	20
	Total	**20**

ELECTIVE COURSES

Sl. No	Title
1.	Agri-Business Management
2.	Management of Natural Resources
3	Agrochemicals
4.	Agricultural Journalism
5.	Landscaping
6.	Commercial Plant Breeding
7.	Food Safety and Standards
8.	Bioformulation and Nanoformulation
9.	Biopesticides and Biofertilizers
10.	System Simulation and Agroadvisory
11.	Hi-tech Horticulture
12.	Protected Cultivation
13.	Climate Resilient Agriculture
14.	Biotechnology of Crop Improvement 3 (2+1)
15.	Geoinformatics and Remote Sensing, Precision Farming
16.	Micro-propagation Technologies
17.	Commercial Seed Production
18.	Principles and Practices of Organic Farming/ Conservation Agriculture
19.	Food Science and Nutrition
20.	Post Harvest Technology and Value Addition

- More electives to be included by the universities / institutions, based on the facilities/ expertise available such as nano feetilizers, robotics, use of drones in agriculture etc

Elective course 1

Agri-Business Management 4 (3+1)

Objectives

To impart knowledge on understanding the concepts processes, significance, and role of management and organizational behaviour

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management: Importance and needs of agro-based industries. Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST and SWOT analysis. Management functions: Roles and activities, Organization culture. Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital management and Financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting and positioning. Marketing mix and marketing strategies. Consumer behaviour analysis, Product Life Cycle (PLC). Sales and Distribution Management. Pricing policy, various pricing methods. Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques.

Practical

Study of agri –input markets: Seed, fertilizers pesticides. Study of output markets: grains, fruits, vegetables, flowers. Study of product market, retails trade commodity trading, and value-added products. Study of financing institutions- Cooperative, Commercial Bank, RRBs, Agribusiness Finance Limited, NABARD. Preparations of projects and Feasibility reports for agribusiness entrepreneur. Appraisal /evaluation techniques of identifying viable project- Non discounting techniques. Case study of agro- based industries. Trend and growth rate of price of agricultural commodities. Net present worth technique for selection of viable project. Internal rate of return.

Suggested readings

1. Broadway, A.C. and Broadway, Arif, A. 2002. A textbook of Agri-Business Management. Kalyani Publishers
2. Bairwa, S.L. 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers
3. Anjan Nishra, Debasish Biswas and Arunangshu Giri. 2019. Agribusiness Management, Himalaya Publishing House, 220p.
4. Shoji Lal Bairwa, Chandra Sen, L.K. Meena and Meera Kumari. 2018. Agribusiness Management Theory and Practices, Write and Print Publications.
5. Virender Kamalvanshi. Agribusiness Management. Random.

Elective course 2

Management of natural resources 4 (3+1)

Objectives

1. To enlighten students about available natural resources and their relationship with crop production
2. To impart the knowledge of principles and practices of natural resource management

Theory

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management. Land resources: Land as a resource. Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification. Landscape impact analysis, wetland ecology and management. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Water ecology and management. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Resource Management Paradigms: Resource management the evolution and history of resource management paradigms. Resource conflicts: Resource extraction, access and control system. Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Introduction to soil and water conservation and causes of soil erosion., Definition and agents of soil erosion, water erosion - Forms of water erosion, Gully classification and control measures. Soil loss estimation by universal soil loss equation - Soil loss measurement techniques. Principles of erosion control - Introduction to contouring, strip cropping. Contour bund - Graded bund and bench terracing. Wind erosion - Mechanics of wind erosion, types of soil movement - Principles of wind erosion control and its control measures, Water harvesting techniques - Lining of ponds, tanks and canal systems.

Practical

Identifying natural resources and their utility. Practicing survey - Principles and educating to use pacing technique for measurement. Area calculations through chain survey - GPS demo for tracking and area measurement. Estimation of soil loss and calculation of erosion index. Leveling concepts and practical utility in agriculture. Preparation of contour maps. Concept of vegetative water ways and design of grassed water ways. Wind erosion and estimation process. Different irrigation pumps and their constructional differences. Farm pond construction and its design aspects. Visit to nearby farm pond. Visit to an erosion site. Exposure to strip cropping/contour bunding.

Suggested readings

1. Sustainable Natural Resource Management by Danill R. Lynch.
2. Management of Natural Resource for Sustainable Development, by Vijay Singh Rathor and B S Rathor, Daya Publishing House.
3. Managing Natural Resources: Focus on Land and Water. Ed. Harikesh N. Mishra. PHI, Learning, 496p.

4. Management of Resources for Sustainable Development: Sushma Goel. The Orient Blackswan 284p.
5. Natural Resources: Their Conservation and Management by Arvindrai Upadhyay. Aspiration Academy, 320p.
6. Natural Resource Management for Growth Development and Sustainability by Vasudeva Srishti Pal.Today & Tomorrows Printers and Publishers, 336p.

Elective course 3

Agrochemicals **4 (3+1)**

Objectives

To impart knowledge on different classes of agrochemicals

Theory

An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture. Herbicides -Major classes, properties and important herbicides. Fate of herbicides. Fungicides- classification –Inorganic fungicides-characteristics, preparation and use of sulphur and copper. Mode of action- Bordeaux mixture and copper oxychloride. Organic fungicides –Mode of action –Dithiocarbamates- characteristics, preparation and use of Zineb and maneb. Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use. Introduction and classification and insecticides: inorganic and organic insecticides organochorine, Ogranophosphates, Carbamates, Synthetic pyrethriods Neonicotinoids, Biorationals. Insecticide Act and rules, Insecticides banned, withdrawn and restricted use. Fate of insecticides in soil and plant. IGR Biopesticides, Reduced risk insecticides, Botanical, Plant and animal systemic insecticides their characteristics and uses. Fertilizers and their importance. Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate. Mixed and complex fertilizers: Sources and compatibility-preparation of major, secondary and micronutrient mixtures. Complex fertilizers: Manufacturing of ammonium phosphates, nitrophosphates and NPK complexes. Fertilizer control order. Fertilizer logistic and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available kin market. Estimation of nitrogen in Urea. Estimation of water soluble P2 O5 and citrate soluble P2 O5 in single super phosphate. Estimation of potassium in Muraite of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide.

Suggested readings

1. Buchel, K.H. (Ed.). 1992. Chemistry of pesticides. John Wiley & Sons
2. Panda, H. 2022.The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides (Agrochemicals) with Formulae, Manufacturing Process, Machinery & Equipment Details. 2nd Revised Edition. NPCS
3. Biswas, D. R. 2021. A Text Book of Fertilizers. New India Publishing Agency
4. Singh, A. 2022. Basics of Agrochemical Formulations, Brillion Publishing, 176p.
5. Larramendy, M.L. 2017. Toxicity and Hazard of Agrochemicals, INTECH, 170p.

Elective course 4

Agricultural Journalism 4 (3+1)

Objectives

To impart knowledge and skill in agricultural journalism

Theory

Journalism – Meaning, nature, importance, and types of journalism. Agricultural Journalism – Meaning, definition, principle, objectives, types, and scope. Similarities and difference between agricultural journalism and other types of journalism. Role of agricultural journalist, Training of agricultural journalist. Qualities of journalist, Role of journalist /journalism in agricultural development and development of newspaper and magazines readers. Newspaper and magazines as communication media: Characteristics, kinds and functions of newspaper and magazines, Characteristics of newspaper and magazines readers. Form, content, style and language of newspaper and magazines, Standard part of newspaper and magazines. The agricultural story: Types of Agriculture stories, subject matter of the agricultural story, structure of the agricultural story. Gathering farm information -Sources of farm information: abstracting from research and scientific materials, interviews, coverage of events. Other sources: electronic media, field study. Success stories-definition, nature, components, guidelines of writing a success story. Writing a news story difference between news and feature story, the principle of writing a news story, Inverted pyramid structure. Organizing the material, treatment of the story, writing the news lead and the body. Readability measure-readability ease score, automated readability index, gunning fog index, How to improve readability of articles and stories. Use of photograph in agricultural journalism- Basic principles of photography – composition, exposure, lens, light. Use of artwork (Graphs, charts maps, etc.). Writing the captions. Editorial mechanism: Copy reading, headline and title writing. Proofreading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader. Layout – meaning, principles of layout and design.

Practical

Practice in writing an agricultural news story. Practice in writing an agricultural feature story. Covering agricultural events for the information collection. Practice in interviewing for the information collection. Abstracting stories from research and scientific materials and wire services. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading. Practice in headline and title writing. Practising proof reading. Practice in lay outing of newspaper. Testing copy with a readability formula. Visit a publishing office.

Suggested readings

1. Introduction to Journalism by Carole Fleming, Emma Hemmingway, and Gillian Moore.
2. Basic Journalism by Rangaswami Parthasarathy.
3. News Reporting and Editing by K. M. Shrivastava.
4. Professional Journalism by M.V. Kamath.
5. The Journalist's Handbook Book by M.V. Kamath.
6. Farm Journalism and Media Management – Bhaskaran et al.
7. Agricultural Extension and farm Journalism – A K Singh.
8. Farm Journalism – Jana and Mitra.
9. Web Materials.
10. Prepared You Tube videos.

Elective course 5

Landscaping 4 (3+1)

Objectives

1.To educate the students on designing different styles and types of gardens

2.To enable the students to identify different ornamental plants and their utilization in landscaping design

3.To enable students to design landscapes in softwares like AUTOCAD, ARCHCADE etc.

Theory

Importance and scope of landscaping. Principles of landscaping, garden styles and types terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery water garden, walk-paths, bridges, other constructed features etc. Gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management. Shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers importance, selection, propagation, planting. Annuals: selection, propagation, planting scheme. Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bio-aesthetic planning: definition, need, planning. Landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions, Bonsai principles and management. Lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals; Care and maintenance of plants, potting and repotting; Identification of tools and implements used in landscape design. Training and pruning of plants for special effects. Lawn establishment and maintenance. Layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software. Visit to important gardens /parks /institutes.

Suggested readings

1. Textbook of floriculture and landscaping by Anil K. Singh and Anjana Sisodia
2. Principles of Landscape Gardening: Y. Chandrasekhar and Hemla Naik B. 2020. ICAR.
3. Introductory Ornamental Horticulture and Landscape Gardening: Rajaneesh Singh and Brijendra Kumar Singh. 2020, Bio-Green Books.
4. Principles of Landscape Architecture: Pragnyashree Mishra and Bhimasen Naik. 2022. New India Publishing Agency.
5. Landscape Gardening: Sudhir Pradhan. 2018. Scientific Publishers India.

Elective course 6

Commercial Plant breeding 4 (3+1)

Objectives

1. To discuss about hybrid development and various crop improvement aspects of field crops viz., rice, wheat, maize, pearl millet, sorghum, pigeonpea, chickpea, green gram, black gram, lentil, soybean, groundnut, rapeseed-mustard, cotton etc.
2. To provide understanding on tissue culture and biotechnological approaches as alternative strategies for development of line and cultivars
3. To impart knowledge on seed production, release and notification of varieties and PPV&FR Act, 2001

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self- and cross- pollinated crops (A/B/R and two-line system) for development of hybrids and seed production. Genetic test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Speed Breeding, Breeding Management systems, High-throughput phenotyping and genotyping platforms, Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line cultivators: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of verities under PPV and FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self- and cross- pollinated crops.

Practical

Floral biology in self- and cross- pollinated species, selfing and crossing techniques. Techniques of seed production in self- and cross- pollinated crops using A/B/R and two-line system. Learning techniques in hybrid seed production using male- sterility in field crops. Understanding the difficulties in hybrid seed production. Tools and techniques for optimizing hybrid seed production. Concept of rouging in seed production plot. Concept of line its multiplication and purification in hybrid seed production. Role of pollinators in hybrid seed production. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops. Sampling and analytical procedures for purity testing and detection of spurious seed. Seed drying and storage structure in quality seed management. Screening techniques

during seed processing, viz. grading and packaging. Visit to public private seed production and processing plants.

Suggested readings

1. Commercial Plant Breeding at a glance by Phundan Singh, Pratibha Bisen, Reshu Tiwari. Daya Publishing House.
2. Plant Breeding: Principles and Methods by B. D. Singh. Kalyani Publishers.
3. Principles of Plant Breeding (1st & 2nd Edition) by R.W. Allard.
4. Breeding Field Crops by J.M. Poehlman.
5. Commercial Plant Breeding Objective: Phundan Singh, Mridula Billore and Monika Singh. Astral Publishing, 160p.
6. Breeding and Crop Production: H. Padmalatha, Random.
7. Biotechnology for Agricultural Breeding: Mangal, S. K. GeneTech Books.

Elective course 7

Food safety and standards 4 (3+1)

Objectives

1. To develop the skills to convert raw materials into safe, attractive food products
2. To manage the production of food products
3. To use scientific knowledge to develop new products

Theory

Food safety –Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Type of Hazards - Biological, Chemical Physical hazards. Management of hazards – Need. Control of Parameters. Temperature Control. Food Storage. Production Design. Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food safety Measures. Food Safety Management Tool- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP.ISO series. TQM- concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygine. Food laws and Standards Indian Food Regulatory Regime, FSSA. Global Scenario CAC. Other laws and standards related to food. Recent concerns -New and Emerging Pathogens. Packaging, Product labelling and Nutritional labelling. Genetically modified food/transgenic. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.

Practical

Water quality analysis physico – chemical and microbiological. Preparation of different types of media. Microbiological examination of different food samples. Assessment of surface sanitation by swab/rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plants for Implementation of FSMS-HACCP, ISO:22000.

Suggested readings

1. Text book of Food Science and Technology: Avantina Sharma.
2. Handbook of Food Safety: D.S.L. Khatekar and N. Sarkate. Step Up Academy, 576p.
3. Food and Beverage Management: Bernard Davis. Andrew Lockwood, Ioannis Pantelidis, Peter Alcott Routle.dge
4. Food safety and Quality Control: Pulkit Mathur. The Orient Blackswan.332p.
5. Safe Food Handling: HACCP booklet for Food Handlers. Cletus Fernandes, Notion Press.

Elective course 8

Bioformulation and Nanoformulation 4 (3+1)

Objectives

1. To enable students to acquire expertise and skill to develop bioformulation and Nanoformulation
2. To know the importance of biopesticides and biofertilizers
3. To make the students know about various techniques involved in biofertilizers and biopesticides production
4. To get knowledge on essential oils, botanicals, predators, parasitoids, pheromones, and parapheromone and their application in insect pest management
5. To get concepts on agrochemical formulations with nanoparticles and acquaint them with nanotechnology.

Theory

Introduction and history of biological control of pests and diseases; Microbial biopesticides: the global and Indian market scenario; biopesticides for organic agriculture; Different phytopathogenic biocontrol agents: Mode of action; Different entomopathogenic biocontrol agents: Mode of action; Microbial inoculants as biofertilizer candidates, Production, quality assessment and methods of application of biopesticides and biofertilizers; Regulatory system of biopesticides in India; Formulations of plant essential oils, botanicals, pheromone, and parapheromone and their application in insect pest management; Use of predators and parasitoids for insect pest management; Nanotechnology: its applications in pest and disease diagnosis and management; Nano biopesticides: Concept and importance, different techniques of producing nano biopesticides; Nano Fertilizers: Concept and importance, Types of nano fertilizers; Different techniques of producing nano fertilizers; Green synthesis of nano fertilizers; green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles

Practical

Introduction and acquaintance with biopesticide laboratory; Preparation of culture media; Isolation and purification of bioagent from soil and infected insects; Microscopic study of different microbial bioagents; In vitro assay of microbial bioagents against plant pathogens.

In vitro compatibility study among different microbial bioagents; Mass multiplication of biopesticides; Population enumeration of biocontrol agents in different biopesticides; Preparation of plant extracts and their efficacy test against insect pests; Use of pheromone parapheromone for

monitoring and management of insect pests; Bioassay of Entomopathogenic biocontrol agents on insect pests; Preparation of microbial inoculants of biofertilizer microbes; Compatibility of biofertilizer microbes; Preparation of solid and liquid consortia of biofertilizer microbes

Suggested readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society.
2. Borkar, S.G. 2015. Beneficial Microbes as Biofertilizers and its Production Technology.
3. Boland, G.J. and David, L.1998. Plant microbe interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
5. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural products.
6. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
7. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services, Bengaluru.
8. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services, Bengaluru.
9. Allhoff, Fritz and Lin, Patrick (Eds). 2009. Nanotechnology and Society. ISBN: 978-1-4020-6208-7 Springer Publications, UK.
10. Prasad, Ram, Vivek Kumar, Manoj Kumar and Devendra Choudhary Eds, 2019. Nanobiotechnology in Bioformulations, Kindle Edition
11. Koul, Opender Ed, 2019. Nano-biopesticides Today and Future Perspectives. Academic Press.
12. Shah, M. A. and Tokeer Ahmad. Nano Science and Technology, Wiley India.

Elective course 9

Biopesticides and Biofertilizers 4 (3+1)

Objectives

1. To provide knowledge on principles, methods, and mechanisms of bio-control agents and their use against plant diseases
2. To provide knowledge on principles, methods, and mechanism of biofertilizers and their use in agriculture

Theory

History and concept of bio pesticides. Importance, scope and potential of bio pesticides. Definitions, concepts and classification of bio pesticides viz. Pathogen, botanical pesticides, and bio rationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes, Methods of application of bio pesticides. Methods of quality control and Techniques of bio pesticides. Impediments and limitation in production and use of bio pesticides.

Biofertilizers - Introduction, status and scope. Structure and characteristics features of bacterial biofertilizers – Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cynobacterial bio fertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers – AM mycorrhiza and ectomycorhiza. Nitrogen fixation –Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production Technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers-Storage, shelf life, quality control and marketing. Factors influencing the efficiency of biofertilizers.

Practical

Isolation and purification of important biopestisides: trichoderma Pseudomonas, Bacillus, Metarhyziumetc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides. Isolation and purification of Azospirillum, Azotobactor, Rhizobium, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi- Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

Suggested readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society
2. Bhatnagar, R.K. and Palta, R.K. Earthworm Vermiculture and Vermicomposting. Kalyani Publishers.
3. Boland, G.J. and David, L.1998. Plant Microbe Interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015. Beneficial Microbes as Biofertilizers and its Production Technology.
5. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
6. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural Products.
7. Gehlot, Dushyent. Organic Farming: Standards, Accreditation, Certification and Inspection. Agrobios (India).
8. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
9. Nehra, Sampat. Biofertilizers for Sustainable Agriculture. Aavishkar Publishers, Jaipur, India.
10. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services, Bengaluru.
11. Singh, Awani Kr. Handbook of Microbial Biofertilizers. Agrotech Press, Jaipur, India.
12. Singh, A.K. Organic Farming. New India Publishing Agency, New Delhi.
13. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services, Bengaluru.
14. Trivedi, P.C. Fungal Biopesticides and VAM applications. Pointer Publishers, Jaipur, India.

Elective course 10

System Simulation and Agroadvisory 4 (3+1)

Objectives

1. To impart the knowledge of statistical and simulation modelling in crop yield estimation
2. To get acquainted with different weather forecasting techniques and their usability analysis
3. To study about the preparation and dissemination of agro-advisory bulletin

Theory

System approach for representing soil-plant-atmospheric continuum, system boundaries. Crop models, concepts and techniques, types of crop models, data requirements, relational diagrams. Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis. Potential and achievable crop production- concept and modelling, techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance. Weather forecasting, types methods, tools and techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop- Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast. Use of crop simulation model for preparation of Agro- advisory and its effective dissemination.

Practical

Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential and achievable production; yield forecasting, insect and disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast. Feedback from farmers about the agro- advisory.

Suggested readings

1. Introduction to Agrometeorology by H. S. Mavi.
2. Agricultural Meteorology by G.S.L.H.V. Prasado Rao.
3. Advances in Plant Atmospheric Interactions (Eds. Rao, V.U.M., Rao, A.V.M.S., Rao, G.G.S.N., Ramana Rao, B.V., Vijaya Kumar, P. and Venkateswarlu, B), Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad.
4. Text Book of Agricultural Meteorology by M.C. Varshneya and P.B. Pillai. ICAR.
5. Principles of Agricultural Meteorology by OP Bishnoi.

Elective course 11

Hi-tech Horticulture 4 (3+1)

Objectives

1. To educate the students on the latest technology of hi-tech horticulture
2. To educate students on the concepts and prospects of hi-tech horticulture

Theory

Introduction and importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods; Protected cultivation: advantages, controlled conditions, method and techniques; Micro irrigation systems and its components; EC, pH based fertilizer scheduling; canopy management; high density orcharding; Components of precision farming: Remote sensing; Geographical Information System (GIS); Differential Geo-positioning System (DGPS); Variable Rate Applicator (VRA); application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical

Types of polyhouses and shade net houses, Intercultural operations, tools and equipment identification and application, Micro propagation, Nursery- portrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Suggested readings

1. Hi-tech Horticulture by T.A. More.
2. Greenhouse Operation and Management by Paul V. Nelson.
3. Hi Tech Horticulture (Pb) by S. Prasad, Dharam Singh and R.L. Bharadwaj. Agrobios
4. Instant Horticulture by S.N. Gupta. Jain Brothers. 488p.
5. Hydroponics for Beginners and Advanced: The Ultimate Hydroponic and Aquaponic Gardening Guide by Tom Garden, Webb Eleanor.

Elective course 12

Protected cultivation 3 (2+1)

Objective

To educate students on the scientific and commercial cultivation of important value-added products in protected cultivation

Theory

Protected cultivation- importance and scope, status of protected cultivation in India and World, types of protected structure based on site and climate. Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers, Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops-rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants. Off- season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, Use of portrays in quality planting material production, Bed preparation and planting of crop for production. Inter cultural

operations, Soil EC and pH measurement. Regulation of irrigation and fertilizers through drip, fogging and misting.

Suggested readings

1. Greenhouse operation and management by Paul V. Nelson.
2. Protected cultivation of Horticultural crops by Madan Kr. Jha, Sujan Singh Paikra and Manju Rani Sahu.
3. Protected Cultivation of Horticulture Crops by Itigi Prabhakar. IBPSS.
4. Advances in Protected Cultivation by Brahma Singh and Balraj Singh. NIPA,252p.
5. Protected Cultivation and Smart Agriculture by Eds. Sagar Maitra, Dinkar J. Gaikwad and Tanmoy Shankar. New Delhi Publishers, 263p.
6. Textbook of Protected Cultivation and Precision Farming for Horticultural Crops by B. Ashok Kumar, Eggadi Ramesh and Sindhu V. Jain Brothers.

Elective course 13

Climate Resilient Agriculture 3 (2+1)

Objectives

1. To impart the concept of climate resilient agriculture under the present context of climate change
2. To study the integrated role of different sectors in building resilience to climate change in agriculture

Theory

Climate change and impacts of climate change on agriculture and food security; crop productivity under different climate change scenarios including extreme events such as drought, flood, pest and disease outbreak etc. Basics of adaption and mitigation in the agricultural sectors; analyzing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options in agriculture; assessing biophysical and socio-economic impacts on agricultural sector; risk assessment strategies, preparedness for weather and climate risks in agriculture; application of geospatial tools and techniques for sustainable agriculture. Climate resilient agriculture (CRA) – concept, scope and importance with special reference to India, climate resilient technologies for enhancing crop productivity and sustainability – role of weather and climatic information, agro-advisories, ICTs and simulation models; climate resilient agronomic practices – crop/cultivar selection, crop diversification/ crop mixtures; water management practices – rain water harvesting, micro-irrigation, deficit irrigation and drainage management, organic/natural farming, integrated farming systems (IFS); site specific nutrient management (SSNM), conservation agriculture technologies to build soil organic carbon, harnessing microbial biodiversity, biomass recycling; use of renewable sources of energy; climate resilient pest-disease management strategies. Breeding strategies for development of climate change resilient crops and varieties, development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios including extreme weather events.

Practical

Acquaintance with meteorological instruments including AWS, Statistical techniques to study trend of climatic parameters, Analysis of extreme weather events using non-parametric tests, Building climate change scenarios under different futuristic emission of GHGs, Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars, Climate resilient technologies and manipulation of cropping patterns, Acquaintance with ICTs for effective dissemination of local weather information and agro-advisories, Analysing carbon sequestration potential of different agro-ecosystems; Designing climate smart village model considering the availability of resources. Awareness programme on climate change and climate resilient agriculture among farming community.

Suggested readings

1. Climate Resilient Animal Agriculture by GSLHV Prasada Rao. New India Publishing Agency.
2. Climate Resilient Agriculture Adaptation and Mitigation Strategies by Bhan Manish. New India Publishing Agency
3. Climate-Smart Agriculture Sourcebook. FAO (2013).
4. Implications for Climate Smart Agriculture by Wahid Hasan, Sachin G. Mundhe, Abdul Majid Ansari and Shivani Kumari. Biotech Books, 357p.
5. Climate Resilient Agriculture, Adaptation and Mitigation Strategies by Manish Bhan. New India Publishing Agency, 294p.
6. Climate Change and Agriculture Over India by Prasad Rao. PHI Learning, 352p.
7. Climate Smart Agriculture for Sustaining Crop Productivity and Improving Livelihood Security by Prakash M. Satish Serial Publishing House.178p.

Elective course 14

Biotechnology of Crop Improvement 3 (2+1)

Objectives

1. To acquaint with biotechnological tools of crop improvement
2. To know about direct and indirect methods of gene transfer
3. To introduce about gene editing in plants
4. To provide knowledge about marker assisted breeding and genomic selection

Theory

Impact of Biotechnology on crop improvement and the perspective of society; Various biotechnological techniques available for crop improvement – Plant Tissue Culture, Genetic Engineering, Genome editing, Marker Assisted breeding and Genomic Selection. Biosafety regulations and their application in Agricultural Biotechnology. Somaclonal variation and its use in crop improvement; embryo culture; anther/pollen culture; somatic embryogenesis; artificial seeds; techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in the improvement of crop plants. Direct and Indirect methods of gene transfer in plants - Agrobacterium-mediated gene transfer in dicots and monocots; Direct DNA delivery methods (microinjection, particle gun method, electroporation); gene targeting; Gene silencing

techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems. Introduction to genome editing – Various tools of genome editing; CRISPR-Cas9 with specific emphasis on Indian regulations; Cloning genomic targets into CRISPR/Cas9 plasmids; electroporation of Cas9 plasmids into cells; purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing; in vitro synthesis of single guide RNA (sgRNA); using Cas9/sgRNA complexes to test for activity on DNA substrates; evaluate Cas9 activity by T7E1 assays and DNA sequence analysis; Applications of CRISPR/cas9 technology in crop plants. Marker Assisted Breeding and Genomic Selection: Introduction to various DNA-based markers and their use in marker-assisted breeding; Foreground Selection, Recombinant Selection and background Selection; Marker-assisted backcross breeding, marker-assisted selection – success stories; Introduction to Genomic Selection.

Practical

Agrobacterium-mediated transformation in Tobacco – preparation of construct, transfer to binary vector, transform Agrobacterium, prepare explant, Inoculation and Co-cultivation, antibiotic based selection of putative transformants, validation using PCR; Genome editing- preparation of CRISPR/CAS construct, direct transfer to plant, analysis of the targets; Planning of a MABB programme – selection of parents, crossing strategies, marker analysis.

Suggested readings

1. Brown, T. A. 2006. Genomes (3rd edn). Garland Science Pub, New York.
2. Gene Cloning and DNA Analysis. 2010. Retrieved from http://biolab.szu.edu.cn/ otherweb/ lzc/genetic%20engineering/courseware/b1.pdf
3. Green, M. R. and Sambrook, J. 2012. Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Kumar, Pranav and Mina, Usha. 2015. Biotechnology: A Problem Approach. Pathfinder Publication.
5. Old, R. W., Primrose, S. B. and Twyman, R. M. 2001. Principles of Gene Manipulation and Genomics 7th Edition: Oxford: Blackwell Scientific Publications.
6. Ram, Hari Har. 2019. Crop Breeding and Biotechnology. Kalyani Publications.
7. Rastogi, S.C. 2020. Biotechnology: Principles and Applications. Narosa.
8. Sander, J.D. and Joung, J.K. 2014. CRISPR-Cas systems for Editing, Regulating and Targeting Genomes. Nat Biotechnol. 32:347-355.
9. Singh, K.H., Kumar, Ajay and Parmar, Nehanjali. 2019. Agricultural Biotechnology at a Glance, science technology.
10. Slater. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford, 400p.

Elective course 15

Geoinformatics and remote sensing, precision farming 4 (3+1)

Objectives

1. Enabling students acquire knowledge on basics of remote sensing technique for precision farming applications

2. o provide a comprehensive knowledge of remote sensing, precision farming and its benefits in improving crop production and soil health management

Theory

Introduction and history of remote sensing; sources, Principles of remote sensing, propagation of radiations in atmosphere; Interaction with matter; Application of remote sensing techniques land use soil surveys; crop stress and yield forecasting; Advantages and disadvantages of remote sensing; Remote sensing institutes in India; Basic Concepts about geoinformatics.

Data sharing; Expert System: Introduction to expert system, Characteristics and features of expert system, Applications of Expert System, Importance of Expert system, Rule based system architecture; Software Agents; Impact of Block chain and it's concepts; Probability and Statistics: Bayes Theorem, correlation and Covariance, Continuous Random variables and probability distribution function, various forms of distributions, central limit theorem; Basics of Machine Learning: Random forest, SVM, ensemble methods; Basics of Deep learning: various model architectures and it's training aspects; Hyperspectral and Thermal Remote Sensing; Proximal Soil and Crop Sensors.

Practical

Familiarization with different remote sensing equipments and data products, Interpretation of aerial photographs and satellite data for mapping of land resources, Global positioning system (GPS), Basics of Geographic Information System (GIS), Georeferencing of toposheets, Digital soil mapping with different variables, Basics of multivariate data analytics, Principal component analysis and regression applications, clustering methods and geostatistics are essential in agricultural studies.

Suggested readings

1. Data Analytics in Bioinformatics: A Machine Learning Perspective. Editor (s): Rabinarayan Satpathy, Tanupriya Choudhury, Suneeta Satpathy and Sachi Nandan.
2. Machine Learning Approaches to Bioinformatics by Zheng Rong Yang.
3. Text Book of Remote Sensing and Geographical Information Systems by M. Anji Reddy.
4. Precision Agriculture Technologies for Food Security and Sustainability By A El-Kader, M Sherine, M El-Basioni and M Basma.
5. Principles and Theory of Geoinformatics by P.K. Garg. Khanna Publishers. 296p
6. Advances in Geoinformatics Remote Sensing and GIS by Bhunia, Gouri Sankar, Uday Chatterjee and Gopal Krishna Panda. BIO GREEN
7. Artificial Intelligence: Machine Learning, Deep Learning, and Automation Processes by John Adamssen. Efalon Acies.
8. Remote Sensing and Image Interpretation, 6th edn (WSE) Paperback – 1 January 2011, Willey Student Edition.
9. Remote Sensing and Geographic Information by A.M. Chandra and S.K. Ghosh. Narosa.

Elective course 16

Micro-propagation Technologies 4 (3+1)

Objectives

To educate the students in detail about the sterilization techniques for explants, preparation of stocks and working solution, culturing of explants, regeneration of whole plants from different explants and hardening procedures.

Theory

Introduction, History, Advantages and limitations. Types of cultures (seed, embryo, organ, callus, cell); Stages of micro propagation; Axillary bud proliferation (Shoot tip and meristem culture, bud culture); Organogenesis (calluys and direct organ formation); Somatic embryogenesis; Cell suspension cultures; production of secondary metabolites; Somaclonal variation; Cryopreservation.

Practical

Identification and use of equipment in tissue culture Laboratory; Nutrition media composition; Sterilization techniques for media, containers and small instruments; Sterilization techniques for explants; Preparation of stocks and working solution; Preparation of working medium; Culturing of explants: Seeds, shoot tip and single node; Callus induction; Induction of somatic embryos regeneration of whole plants from different explants; Hardening procedures.

Suggested readings

1. Basics of Horticulture by Jitendra Singh
2. Introduction to Horticulture by N. Kumar
3. Handbook of Horticulture by ICAR.
4. Plant Tissue Culture: Basic and Applied by Timir Baran Jha and Biswajit Ghosh. Platinum Publishers. 439p.

Elective course 17

Commercial Seed Production 4 (3+1)

Objectives

To introduce the basic principles of planting material production at commercial scale and seed quality evaluation

Theory

General Principles of Seed Production: Raising the seed crop, Introduction, Procurement of a class of Improved seeds, Reporting to Monitoring or certification Agency, Principles and practices of selection of area and agronomic requirement of seed production of field crops, Importance of isolation distance and Rouging, Principles of hybrid seed production in field crops, Principles and practices of selection of area and agronomic requirement of seed production of horticultural crops, Concept of apomixes, male sterility and self-incompatibility and its application in hybrid seed production of horticultural crops, Farmers participatory seed production.

General Principles of Seed Processing: Introduction, Objectives of Seed Processing, Seed Drying, Principles of Drying, Water vapour equilibrium, Methods of drying seeds, Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids, Seed treatment, Temperature treatment, Chemical treatment, Bagging and Labelling.

General Principles of Seed Testing: Seed testing-Introduction, Procedure of Seed testing, components of seed quality testing genetic, physical, physiological and seed health testing, Seed sampling, Types of seed sampling, Requirements of sampling, Concept of seed viability and vigour; dormancy, types and principles of seed dormancy, Physiological quality of seed, Principles of seed Germination, types of germination, biochemical and genetic basis.

Seed Certification: History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed Certification Standards (I.M.S.C.S.) - general and specific crop standards including GM varieties, field and seed standards.

Seed Industry and Seed Marketing: Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry, Seed marketing – concept, definition and purpose, importance and promotion of quality seed, formal and informal seed supply systems, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labelling, Seed Associations, Factors influencing seed marketing, Seed marketing programs, Seed industry organizations, Marketing of public versus private players, Demand and supply of seed; role of seed replacement rate (SRR), seed multiplication ratio (SMR), economics of seed production; determining seed needs, Seed pricing and price policy, seed processing and / packaging, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand, Role of WTO in seed marketing.

Biotechnology in Seed Technology: History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micro-propagation, Problems associated with micro-propagation, Synthetic seed production, Types of synthetic seeds, methods of development of synthetic seeds, Components of nutrient media for synthetic seed development, Storage of synthetic seeds, Advantages and limitations of synthetic seed production.

Practical

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate

Operation and handling of mechanical drying equipment; effect of drying temperature and duration on seed germination and storability seed processing equipment; seed treating equipment.

Seed production in cross pollinated crops with special reference to land, isolation, Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato, Hybrid seed production in Maize, detasseling in maize, identification of rogues and pollen shedders, Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc., Visit to seed processing plant and commercial controlled and uncontrolled

Seed Stores, Seed industries and local entrepreneurships visit to nearby areas, Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, detection of seed-borne fungi, bacteria and viruses, identification of storage fungi, control of seed-borne diseases, seed treatment methods., Maintenance of aseptic conditions and sterilization techniques, Preparation of nutrient stocks for synthetic media, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Inoculation of explants for micro-propagation, Inoculation of explants for callus induction and subsequently regeneration of plantlets from matured seeds of field and horticultural crops, Synthetic seed preparation.

Suggested readings

1. Agarwal, R.L. 1997. Seed Technology. 2nd edn. Oxford & IBH.
2. McDonald, M.B. Jr and Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall
3. Thompson, J.R. 1979. An Introduction to Seed Technology. Leonard Hill.
4. Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani.
5. Justice, O.L. and Bass, L.N. 1978. Principles and Practices of Seed Storage. Castle House Publ. Ltd.
6. Tunwar, N.S. and Singh S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.
7. Chawla, H.S. 2008. Introduction to Plant Biotechnology. 2nd edn. Oxford &IBH publishing Co. Ltd. 113-B Shahpur Jat, New Delhi-110049.

Elective Course 18

Principles and Practices of Organic Farming and Conservation Agriculture 2 (1+1)

Objectives

1. To teach students the principles of crop production under organic and conservation agriculture situation
2. To impart practical knowledge of organic and conservation agriculture practices

Theory

Concept of organic farming, principles and its scope in India; Choice of crops and varieties in organic farming; Nutrient management in organic farming and their sources; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and crop standards of organic farming; Processing, labelling, economic considerations and viability, marketing and export potential of organic products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture. Conservation agriculture: definition, origin, principles, advantages, challenges; Primary practices in conservation agriculture: minimum soil disturbance, crop residue retention, and crop diversification, complementary practices, conservation agriculture vis a vis Climate Smart Agriculture; Organic manures- recommended doses and application in comparison to inorganic fertilizers for major crops.

Practical:

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost and their quality analysis; Method of application of bio-fertilizers; Indigenous technology knowledge (ITK) for nutrient, insect-pest and disease management; Studies in green manuring in-situ and green leaf manuring, Studies on different type of botanicals for insect-pest management; Weed management in organic farming; Cost of organic production system; Practices of conservation agriculture.

Suggested readings

1. A.C. Gaur. Handbook of Organic farming and biofertilizers.
2. A.K. Dahama. Organic Farming for Sustainable Agriculture. Agrobios (India), Jodhpur.
3. Arun. K. Sharma. Handbook of Organic Farming. Agrobios (India), Jodhpur.
4. S.P. Palaniappan and K. Annadurai. Organic Farming – Theory and Practice. Scientific Publishers. Jodhpur.
5. U. Thapa and P. Tripathy. Organic Farming in India- Problems and Prospects. Agrotech publishing agency, Udaipur.
6. G.K. Veeresh. Organic Farming. Foundation Books. New Delhi.
7. Purshit, S.S. Trends in Organic Farming in India. AgrosBios (India), Jodhpur.
8. Thampan, P.K. Organic Agriculture. Peckay tree Crops Development Foundation, Cochin, Kerala.
9. Sathe, T.V. Vermiculture and Organic Farming. Days Publishing House, New Delhi.
10. Singh, Abhinandan, Pankaj Kumar Ojha and Rahul Kumar, 2018. Conservation Agriculture Technologies. Biotech Books.
11. Acharya Sankar Kr, Sreemoyee Bera, Cornea Saha, Prabhat Kumar, Monirul Haque, Riti Chatterjee and Anwesha Mandal. 2022. Conservation Agriculture Approach and Application. Scholars World. 292p.

Elective Course 19

Food Science and Nutrition **4 (3+1)**

Objectives

To impart knowledge on the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration

Theory

Introduction on fundamentals of foods and human nutrition; Basic food groups; Concept of balanced diets; Recommended Daily Allowances (RDA) for various age groups; Biochemical composition, energy and food value of various food grains, fruits and vegetables; Carbohydrates, proteins, fats as nutrients and their interactions; Physio-chemical, functional and nutritional characteristics of essential nutrients- sources and functions, Nutritional requirements, malnutrition, inborn errors of metabolism, deficiency diseases; Digestion, absorption, transport and metabolism of nutrients in human system; Protein quality evaluation. Biochemical and nutritional aspects of

vitamins, minerals, nutraceuticals, antioxidant, antinational factors and biochemistry of post-harvest storage, losses during processing. Effect of cooking, processing and preservation on nutrients of different food products, biochemical aspects of food spoilage; Food fads, food safety and quality standards. Enzymes in food industry, food additives, nutritional quality of plant, animal, dairy, marine and fermented products.

Practical

Proximate analysis of foods; calorific value of foods; Estimation of vitamins, phenols and flavonoids, carotenoids, antinutrients like Phytate/ Oxallate, Trypsin and Chymotrypsin inhibitor activities, limiting amino acids in food stuff.

Suggested readings

1. Damodaran, S. and Parkin, K.L. (Ed.). 2017. Fennema's Food Chemistry. CRC Press
2. Gibney, M.J., Lanham-New, S.A., Cassidy, A. and Voster, H.H. (Ed.). 2009. Introduction to Human Nutrition. Wiley-Blackwell.
3. Trueman, P. 2007. Nutritional Biochemistry. MJP Publishers.
4. Rekhi, Tejmeet and Yadav, Heena. 2014. Fundamentals of Food and Nutrition. Elite Publishing House. 257p.
5. Dharmesh Kumar. Food Science and Nutrition. Random.

Elective Course 20

Post Harvest Technology and Value Addition 2 (1+1)

Objectives

1. To educate about the different pre-harvest, harvest and post-harvest factors affecting the post-harvest life of fruits and vegetables
2. To educate about preparation techniques of value-added products
3. To educate about the different dehydration techniques of horticultural crops

Theory

Importance of post –harvest processing of fruits and vegetables, extent and possible causes of post-harvest losses: Pre-harvest factors affecting post-harvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food (jam, jelly, marmalade, preserve, candy) - concepts and standards; Fermented and non-fermented beverages. Tomato products -concepts and standards; Drying /Dehydration of fruits and vegetables –concept and methods, osmotic drying. Canning – concepts and standards, packaging of products.

Practical

Applications of different types of packing, containers for shelf-life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, RTS,

nectar, squash, osmotically dried products, fruit bar candy and tomato products, canned products. Quality evaluation of products- Physico-chemical and sensory. Visit to processing unit/industry.

Suggested readings

1. Post-harvest technology of horticultural crops by S.K. Sharma and M.C Nautiyal.
2. Post-Harvest Technology by Suja Nabi Qureshi, Kounser Javeed and Abhay Kumar Sinha. Bioscientific Publishers.
3. Postharvest Technology of Horticultural Crops by K.P. Sudheer and V. Indira. New India Publishing Agency. 320p.
4. Postharvest Management and Value Addition by Aswini Kumar Goel, Rajender Kumar and Satwinder S. Mann. Daya Publishing House.
5. Postharvest Management and Value Addition of Fruits and Vegetables by Kureel M.K. Biotech, 181p.

Semester VIII

S. No	Course tilte	Total credits
1	For student opting 4 year BSc. (Hons.) degree Student READY (RAWE) / Experiential Learning / Hands on Training / Industrial Attachment /Project Work / Internship etc.	20
	Total	**20**

SKILL ENHANCEMENT COURSE (SEC)

A student admitted into 1st year of B.Sc. (Hons) Agriculture degree program will take 2 skill enhancement courses each of 2 credits in each semester of first year. Likewise, the student continuing his study into 2nd year of B.Sc. (Hons) Agriculture will undergo 1 skill enhancement course of 2 credits in each of the 2 semesters of 2nd year.

The student can select these courses from a bouquet of skill enhancement courses as indicated below or courses offered by a college. The courses may be offered as module of complementing courses to help the student to achieve skill in a specific area of his interest.

The University/HAEIs may offer such skill enhancement courses in which it has strength/ expertise as well as there is prospect of local employment and entrepreneurship development. The courses included in the list are indicative and the University/HAEIs may add more need-based courses in the list depending on their facilities and expertise available.

Indicative skill Enhancement courses

S. No	Course title	Total credits
1	Biofertlizer and biopesticide production	2 (0+2)
2	Production Technology of Bioagents	2 (0+2)
3	Seed Production and Testing Technology	2 (0+2)
4	Mushroom Production Technology	2 (0+2)

S. No	Course title	Total credits
5	Soil, Plant and Water Testing	2 (0+2)
6	Post-harvest Processing Technology	2 (0+2)
7	Beneficial Insect Farming	2 (0+2)
8	Plantation Crop Production and Processing	2 (0+2)
9	Poultry Production Technology	2 (0+2)
10	Piggery Production Technology	2 (0+2)
11	Commercial Horticulture	2 (0+2)
12	Floriculture and Landscaping	2 (0+2)
13	Food Processing	2 (0+2)
14	Agriculture Waste Management	2 (0+2)
15	Organic Production Technology	2 (0+2)
16	Commercial Sericulture	2 (0+2)
17	Video Production	2 (0+2)

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons) Agriculture.

The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The students will take prior approval of the courses they opt from the concerned Dean/Assoc. Dean/Principal of the Faculty/College/Institute.

The courses will be non-gradial as separate certificates would be issued by the Institute/ University offering the courses.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

AGRICULTURAL ENGINEERING

Course Curricula for Undergraduate Programme in Agricultural Engineering UG- Certificate in Agricultural Engineering UG- Diploma in Agricultural Engineering B. Tech. (Agricultural Engineering)

INTRODUCTION

In the recent years, the technological developments in agricultural engineering have seen rapid momentum, specifically in the fields of precision agriculture, high-efficiency irrigation systems, farm energy systems, remote sensing and geographical studies, etc. Digital agriculture, smart farming systems; internet of things (IoT), sensors, automation and robotics, etc. are finding more and more applications. Intelligent machines and autonomous vehicles are being introduced to increase efficiency and reduce environmental impact. There is a focus on optimizing food processing operations through the measurement of food properties, innovations in equipment design, and advancements in heat and mass transfer. Agricultural engineering has also expanded to include environmental aspects, with a focus on sustainable agricultural systems and the integration of expertise from various engineering fields with biological and socio-economic sciences. In addition to addressing the challenges such as increasing agricultural production, the discipline is evolving to meet the needs of sustainable development, such as improved food security and reduced poverty, and reducing gaseous emissions from agricultural production, which have been contributing towards the UN Sustainable Development Goals. Progress in agricultural engineering technologies and related applications has been leading to the globalization of agricultural mechanization and modernization. Even in the developing countries, agricultural engineering is playing a major role for moving towards more commercialization of agriculture. Hence, the education and research in agricultural engineering in appropriate areas have become of paramount importance in the present context.

However, the actual benefits of these can be properly harvested only if the students have sound exposure to the latent developments in the field in addition to having due acquaintance with the traditional and indigenous knowledge in the related fields. Also, it is imperative

that the students acquire both professional and soft skills to contribute to the proper adoption of technologies by the society. It will also make the students more acceptable and fitting as a leader of change that the society strives to see in the next generation graduates.

In view of these, the restructuring of under-graduate programs in Agricultural Engineering has been carried out as per NEP guidelines. It is aimed to build among students a strong foundation of knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge. The restructured course curriculum aims at strengthening critical thinking, creativity, communication and collaboration among students. More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has also been made for advanced skill development through project work or experiential learning/ incubation, etc. These activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and critical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

The details of the course structure for the Undergraduate courses in Agricultural Engineering (UG-Certificate, UG-Diploma and B. Tech.) have been prepared after having multistage in-depth deliberations and discussions with the Deans and faculty members of the Agricultural Engineering discipline of different SAUs and CAUs, stakeholders from related industries, Govt. Institutions and alumni. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The B. Tech. (Agricultural Engineering) programme will be of 180 credits, which includes 174 credits offered by the parent institute and 6 credits of online courses (to be taken by the student as per his/her/ze choice). In addition, there will be four credits of two non-gradial courses (*Deeksharambh* (Introduction-cum-Foundation course): 2 credits and Study tour: 2 credits).
- After the admission of students in the university, the students will register for the *Deeksharambh* of two weeks' duration in the 1st semester. The course will include, but not restricted to, discussions on operational framework of academic process in university, interactions with alumni, business leaders, scientists and perspective employers, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated for skill development/ enhancement in agricultural engineering sector with few introductory courses. After satisfactory completion of 1st year (two semesters) and subsequent satisfactory completion of 10 credits (10 weeks) of industry/

institute training/ internship, the student will become eligible for the award *of UG-Certificate in Agricultural Engineering* on exit. The students continuing the study further, would not have to attend the internship after 1st year.

- The second year has been designed with the basic engineering courses as well as fundamental courses in agricultural engineering with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural engineering. After satisfactory completion of the courses of 2nd year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of *UG-Diploma in Agricultural Engineering* on exit. The students continuing the study further, would not have to attend the internship after 2nd year.

- The Skill Enhancement courses will be offered in three stages. In the first year, the course entitled Skill Enhancement (8 credits) will aim at skill enhancement for employment and entrepreneurship. The students will have flexibility and choice in selection of skill areas from a bouquet of skill enhancement modules to be offered/ listed by the parent institute. After two to three days' common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.

- In the final year, the Project-I (3 credits in 7th semester) and Project-II (4 credits in 8th semester) are meant for advanced skill development for research, employment and entrepreneurship. Under these courses, the student will have the option to take up a research project (R and D based, field study based) for developing research skills in form of project or take up incubation/ experiential learning-based activity for entrepreneurship development. The Project-I and - II can also be taken up in collaboration with any organization/ industry.

- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running the Skill Enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.

- The third year and fourth year courses have been designed to impart specialized knowledge to the students in the major disciplines. In the final year, the student will have the liberty to choose any three elective subjects, preferably from one or related disciplines. The objective is to enable the student to acquire deeper understanding in any particular field.

- There will be adequate choice of electives/ specialized courses for the students. The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The student may also opt any relevant course offered in the same semester by other constituent colleges of the HAEI as Elective.

- In the final year, the students will also undergo an 8-week In-plant training/ research internship to expose them to real working situations in industry/ research institutions. In-plant training may be conducted in split manner in more than one industry/ organization/ institute.
- During the 5th semester, the students will have a study tour of 10-14 days duration, which will be counted as 2 credits (Non-gradial).
- The students will take a minimum of 6 credits of online courses (any one or more courses totaling at least 24 weeks or 80 hours' duration) during the third and fourth year as a partial requirement for the B. Tech. (Agricultural Engineering) programme. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- At each stage of exit (UG-Certificate/ UG-Diploma and B. Tech.), the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own enterprise. The social skills acquired by the students will also make the students more empathetic towards the society and social issues.
- The credits (and contact hours) have been proposed in such a way that class room teaching can be accommodated in 5 days in a week. On Saturdays, the students will take up activities as NSS/ NCC, 'Physical Education, First Aid and Yoga Practice' during the 1st and 2nd year. The courses as Seminar and Case study (with analysis and presentation of findings in seminars as well as in reports form) will be taken in the 3rd year. This will increase their acquaintance with the social/ technical problems, improve their analytical ability of the issues/ challenges and enhance their social responsibility. However, these are suggestive only and the Universities can plan their timetables as per the local facilities/ university norms and needs.
- In case the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, the students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

Entry and Exit Options

The entry and exit options for the UG programs in Agricultural Engineering are shown in the Figure 1

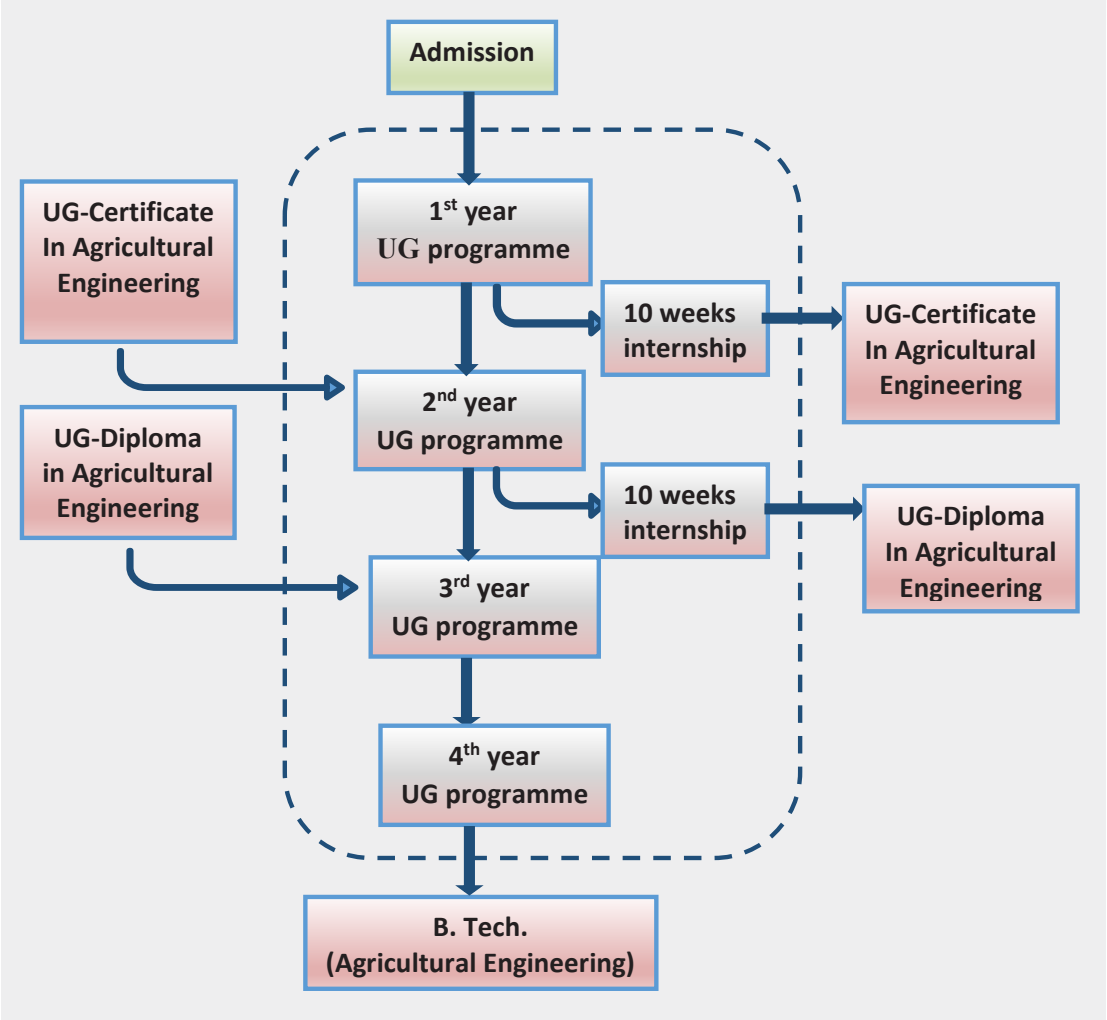

Fig. 1 Entry and Exit options for the UG programs in Agricultural Engineering

Eligibility for Entry into 1st year UG programme

+2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU.

Exit options

1. **UG-Certificate in Agricultural Engineering** (exit after first year and completion of 10 weeks' internship).
2. **UG-Diploma in Agricultural Engineering** (exit after second year and completion of 10 weeks' internship).
3. **B. Tech. (Agricultural Engineering)** (on successful completion of four-year degree requirements).

The Universities may consider allowing lateral entry for the candidates having Diploma in Agricultural Engineering (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having Diploma in Agricultural Engineering (with minimum 3 years course programme after 10th or equivalent) may be allowed admission into the 2nd year of the UG programme, as per the provisions to be notified by the respective AU from time to time.

ACADEMIC PROGRAMME

Semester wise course distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
First Year			
I semester			
1	*Deeksharambh*	0+2 (NG) Non-gradial	**20 (11+9)**
2	Crop Production and Protection Technologies	4 (3+1)	
3	Introduction to Agricultural Engineering	4 (3+1)	
4	Surveying and Levelling	3 (1+2)	
5	Workshop Technology and Practice	2 (0+2)	
6	Basic Electrical Gadgets and Instruments	3 (2+1)	
7	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8	NSS- I/ NCC- I	1 (0+1)	
II semester			
1	Skill Enhancement	8 (0+8)	**21 (5+16)**
2	Engineering Drawing	2 (0+2)	
3	Computer Programing and Data Structures	2 (0+2)	
4	Farming Based Livelihood Systems	3 (2+1)	
5	Environmental Studies and Disaster Management	3 (2+1)	
6	Communication Skills	2 (1+1)	
7	NSS-II/ NCC- II	1 (0+1)	
Post-II semester			
1	Internship (for 10 weeks, only for exit option for award of UG-Certificate)	10 (0+10)	
Second Year			
III semester			
1	Engineering Mathematics- I	3 (3+0)	**25 (16+9)**
2	Engineering Physics	3 (2+1)	
3	Engineering Chemistry	3 (2+1)	
4	Engineering Mechanics	3 (2+1)	
5	Soil Mechanics	2 (1+1)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
6	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	
7	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	
8	Farm Machinery & Equipment- I	3 (2+1)	
9	Physical Education, First Aid, Yoga Practice and meditation	2 (0+2)	
IV semester			
1	Engineering Mathematics-II	3 (3+0)	**25 (18+7)**
2	Theory of Structures	2 (1+1)	
3	Building Construction & Cost Estimation	2 (2+0)	
4	Watershed Hydrology	3 (2+1)	
5	Soil and Water Conservation Engineering	3 (2+1)	
6	Farm Machinery & Equipment II	3 (2+1)	
7	Renewable Energy Sources	3 (2+1)	
8	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
9	Entrepreneurship Development and Business Management	3 (2+1)	
Post-IV semester			
1	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10 (0+10)	
Third Year			
V semester			
1	Strength of Materials	2 (1+1)	**21 (15+6) +2 (Non-gradial)**
2	Theory of Machines	2 (2+0)	
3	Thermodynamics and Heat Transfer	3 (3+0)	
4	Tractor & Automotive Engines	3 (2+1)	
5	Irrigation and Drainage Engineering	4 (3+1)	
6	Food and Dairy Engineering	4 (3+1)	
7	Personality Development	2 (1+1)	
8	Seminar	1 (0+1)	
9	Study tour	2 (0+2) NG	
VI Semester			
1	Tractor Systems & Controls	3 (2+1)	**21 (13+8)**
2	Groundwater, Wells and Pumps	3 (2+1)	
3	Sensors, AI and Robotics in Agriculture	3 (2+1)	
4	Agricultural Structures & Environment Control	3 (2+1)	
5	Bioenergy Systems: Design and Applications	3 (2+1)	
6	Refrigeration and Air-conditioning	3 (2+1)	
8	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
9	Case Study	1 (0+1)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
Fourth Year			
VII semester			
1	Project- I	3 (0+3)	**20 (10+10)**
2	Engineering Graphics and Design	2 (0+2)	
3	Food Quality and Safety	3 (2+1)	
4	Watershed Planning and Management	3 (2+1)	
5	Sprinkler & Micro Irrigation Systems	2 (1+1)	
6	Machine Design	2 (2+0)	
7	Electrical Machines	3 (2+1)	
8	Agricultural Statistics and Data Analysis	2 (1+1)	
VIII semester			
1	Project -II	4 (0+4)	**21 (6+15)**
2	In-plant Training/ Research Internship	8 (0+8)	
4	Elective- I	3 (2+1)	
3	Elective- II	3 (2+1)	
4	Elective- III	3 (2+1)	
		TOTAL	**174 (94+80)**
	*On-line courses	6	**6**
		Grand Total	**174+6***

Department/ section wise course breakup

Sl. No.	Course Title	Credit hours	Total
Foundation courses/ Ability Enhancement Courses, etc.			
1	Deeksharambh	0+2 (Non-gradial)*	4 (0+4)
2	NSS-I/ NCC - I	1 (0+1)	
3	NSS-I/ NCC - II	1 (0+1)	
4	Physical Education, First Aid and Yoga Practice	2 (0+2)	
Basic Agriculture			
1	Crop Production and Protection Technologies	4 (3+1)	12 (8+4)
2	Farming Based Livelihood Systems*	3 (2+1)	
3	Environmental Studies and Disaster Management*	3 (2+1)	
4	Agricultural Statistics and Data Analysis	2 (1+1)	
Social Sciences			
1	Communication Skills*	2 (1+1)	7 (4+3)
2	Personality Development*	2 (1+1)	
2	Entrepreneurship Development and Business Management*	3 (2+1)	

Sl. No.	Course Title	Credit hours	Total
Common Agricultural Engineering			
1	Introduction To Agricultural Engineering	4 (3+1)	6 (3+3)
2	Seminar	1 (0+1)	
3	Case Study	1 (0+1)	
4	Study Tour	2 (0+2) NG*	
Skill Enhancement Courses/ Project			
1	Skill Enhancement	8 (0+8)	15 (0+15)
2	Project- I	3 (0+3)	
3	Project- II	4 (0+4)	
In-plant training/ Internship			
1	Internship only for exit option with UG-Certificate	10 (0+10)#	8 (0+8) #Credits not included in the total credits calculated for B. Tech. programme
2	Internship only for exit option with UG-Diploma	10 (0+10)#	
3	In-plant Training/ Research Internship	8 (0+8)	
Basic Sciences			
1	Engineering Mathematics- I	3 (3+0)	12 (10+2)
2	Engineering Mathematics- II	3 (3+0)	
3	Engineering Physics	3 (2+1)	
4	Engineering Chemistry	3 (2+1)	
Agricultural Structures and Civil and Environmental Engineering			
1	Surveying and Levelling	3 (1+2)	17 (10+7)
2	Engineering Mechanics	3 (2+1)	
3	Soil Mechanics	2 (1+1)	
4	Theory of Structure	2 (1+1)	
5	Building Construction and Cost Estimation	2 (2+0)	
6	Strength of Materials	2 (1+1)	
7	Agricultural Structures and Environmental Control	3 (2+1)	
Mechanical Engineering			
1	Workshop Technology and Practices	2 (0+2)	16 (9+7)
2	Engineering Drawing	2 (0+2)	
3	Theory of Machines	2 (2+0)	
4	Thermodynamics and Heat Transfer	3 (3+0)	
5	Refrigeration and Air Conditioning	3 (2+1)	
6	Machine Design	2 (2+0)	
7	Engineering Graphics and Design	2 (0+2)	
Electrical and Electronics Engineering			
1	Basic Electrical Gadgets and Instruments	3 (2+1)	6 (4+2)
2	Electrical Machines	3 (2+1)	

Sl. No.	Course Title	Credit hours	Total
Computer Science and Engineering			
1	Agricultural Informatics and Artificial Intelligence*	3 (2+1)	8 (4+4)
2	Computer programming and data structures	2 (0+2)	
3	Sensors, Artificial Intelligence and Robotics in Agriculture	3 (2+1)	
Farm Machinery and Power Engineering			
1	Farm Machinery and Equipment- I	3 (2+1)	12 (8+4)
2	Farm Machinery and Equipment- II	3 (2+1)	
3	Tractor and Automotive Engines	3 (2+1)	
4	Tractor Systems and Controls	3 (2+1)	
Renewable Energy Engineering			
1	Renewable Energy Sources	3 (2+1)	6 (4+2)
2	Bio-energy Systems: Design and Applications	3 (2+1)	
Soil and Water Conservation Engineering			
1	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	12 (8+4)
2	Watershed Hydrology	3 (2+1)	
3	Soil and Water Conservation Engineering	3 (2+1)	
4	Watershed Planning and Management	3 (2+1)	
Irrigation and Drainage Engineering			
1	Irrigation and Drainage Engineering	4 (3+1)	9 (6+3)
2	Groundwater, Wells and Pumps	3 (2+1)	
3	Sprinkler and Micro Irrigation Systems	2 (1+1)	
Processing and Food Engineering			
1	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	15 (10+5)
2	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
3	Food and Dairy Engineering	4 (3+1)	
4	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
5	Food Quality and Safety	3 (2+1)	

* Common courses across the disciplines

ELECTIVE COURSES

1	Mechanics of Tillage and Traction	3 (2+1)	9 (any three courses to be chosen)
2	Farm Machinery Design and Production	3 (2+1)	
3	Tractor Design and Testing	3 (2+1)	
4	Hydraulic Drives and Controls	3 (2+1)	

5	Human Engineering and Safety	3 (2+1)	
6	Precision Agriculture and System Management	3 (2+1)	
7	Photovoltaic Technology and Systems	3 (2+1)	
8	Wind Power Technology and Systems	3 (2+1)	
9	Waste and By-products Utilization	3 (2+1)	
10	Floods and Control Measures	3 (2+1)	
11	Remote Sensing and GIS Applications	3 (2+1)	
12	Information Technology for Land and Water Management	3 (2+1)	
13	Wasteland Development	3 (2+1)	
14	Minor Irrigation and Command Area Development	3 (2+1)	
15	Management of Canal Irrigation System	3 (2+1)	
16	Water Quality and Management Measures	3 (2+1)	
17	Landscape Irrigation Design and Management	3 (2+1)	
18	Application of Plastics in Agriculture	3 (2+1)	
19	Precision Farming Techniques for Protected Cultivation	3 (2+1)	
20	Environmental Engineering	3 (2+1)	
21	Development of Processed Food Products	3 (2+1)	
22	Food Packaging Technology	3 (2+1)	
23	Food Plant and Equipment Design	3 (2+1)	
24	Emerging Technologies in Food Processing	3 (3+0)	
25	Processing of Livestock, Fish and Marine Products	3 (2+1)	
26	Food Business Management and Entrepreneurship Development	3 (3+0)	
27	MATLAB Programming	3 (1+2)	
28	Python Programming	3 (1+2)	
29	Artificial Intelligence	3 (2+1)	
30	Advances in Automation and Robotics in Agriculture	3 (2+1)	
31	Machine Learning	3 (2+1)	
32	Operations Research	3 (3+0)	
33	Mechatronics	3 (2+1)	
34	Natural Fibres: Extraction & Properties	3 (2+1)	
35	Natural Fibre Applications in Agriculture	3 (2+1)	
36	Processing of Natural Fibres	3 (2+1)	
37	Agricultural Marketing and Trade	3 (2+1)	

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major & minor/s)	:	125
Common courses (MDC+VAC+AEC)	:	26
Skill Enhancement Courses (SEC)	:	8
Internship/ in-plant training	:	8
Project		7
* Online courses	:	6
Total	:	**174+6***

The credits of *Deeksharambh* (0+2) and Study tour (0+2) have not been included in the total 180 credit hours.

Credits allocation scheme of UG Agricultural Engineering programs is given in Table-1

Table 1 Credits Allocation Scheme of UG Agricultural Engineering programs (Credit hours)

Sem-ester	Core Courses* (majors/ Minors)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill En-hancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial courses	Online Cours-es/ MOOC
I	12	4(2)	3(3)	1(4)	-	-	20	2(1)	
II	2	3(5)	3(6)	2(7) +1(8) + 2(9)	8	-	21	-	
Post-II semester	-	-	-	-	-	10(10)			
III	23	-		2(11)	-	-	25		
IV	22	3(12)	-	-	-	-	25	-	**6**
Post-IV semester	-	-	-	-	-	10(13)			
V	19	-	-	2(14)	-	-	21	2(15)	
VI	21	-	-	-	-	-	21	-	
VII	17	-	-	-	-	3	20	-	
VIII	9	-	-	-	-	12	21	-	
Total	**125**	**10**	**6**	**10**	**8**	**15**	**174**	**4**	**6**

(1) *Deeksharambh* (Induction-cum-Foundation Course); (2) Crop Production and Protection Technologies

(3) Agricultural Informatics; (4) NCC-I/ NSS-I; (5) Farming Based Livelihood Systems;

(6) Environmental Studies and Disaster Management; (7) Communication Skills;

(8) NCC-II/ NSS-II; (9) Computer Programming and Data Structures

(10) Internship (only for those opting for an exit with UG-Certificate)

(11) Physical Education, First Aid and Yoga Practices

(12) Entrepreneurship Development and Business Management

(13) Internship (only for those opting for an exit with UG-Diploma); (14) Personality Development; (15) Study tour

*Includes the Elective courses.

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Programme) 0+2 (NG)

The activities to be taken under *Deeksharambh*, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform f.or

- Helping students from different backgrounds for cultural integration
- Knowing about the operational framework of academic process in university
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

I. discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

II. creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario

III. interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences;

IV. group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences;

V. field visits to related fields/ establishments; and

VI. sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.

Crop Production and Protection Technologies 4 (3+1)

Objective

To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences and to have an idea of the different types of machineries/ equipment that can be adopted for these operations

Theory

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage, tilth and its characteristics; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture.

Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping.

Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter– its composition and decomposition, effect on soil fertility; Soil reaction – acidic, saline and sodic soils; Quality of irrigation water.

Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

Types of horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural crops and their management.

Practical

Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test; Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse/ polyhouse.

Suggested Readings

1. Ahamad S, Anwar Ali and Sharma P K (Eds). 2018. *Plant Disease Management in Horticultural Crops*. Daya Publishing House, Delhi.
2. Biswas T D and Mukharjee S K. 1987. *A Text Book of Soil Science*. Tata McGraw-Hill publishing Co. Ltd.
3. Brady N C and Ray R Weill. 2002. *The Nature and Properties of Soil*. Pearson Education Inc. New Delhi.
4. Chadha K L. 2003. *Handbook of Horticulture*. ICAR Publication, New Delhi.
5. Das D K. 2020. *Introductory to Soil Science*. Kalyani publication, Ludhiana.
6. Dey G C. 2013. *Fundamentals of Agronomy*. Jain Book Depot.
7. Ghildyal B P and Tripathy R P. 1987. *Soil Physics*. Wiley Eastern Ltd., New Delhi.
8. Hillel D. 1982. *Introduction to Soil Physics*. Academic Press, New York.
9. Indian Society of soil science. 2002. *Fundamentals of Soil Science*. ISSC, IARI, New Delhi.

10. Janick J. 1979. *Horticultural Science*. Surjeet Publications, Delhi.
11. Kumar N. 2017. *Introduction to Horticulture*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Muthukrishnan N, Ganapathy N, Nalini R and Rajendran R. 2005. *Pest Management in Horticultural Crops*. New Madura Publishers, Madurai, Tamil Nadu.
13. Reddy S R. 2020. *Principles of Agronomy*. Kalyani Publisher.
14. Reddy Yellamanda T and Reddy Shankar G H. 1995. *Principles of Agronomy*. Kalyani Publishers Ludhiana.
15. Sehgal J L. 1996. *Soil Pedology*. Kalyani publication, Ludhiana.
16. Singh Jitendra. 2018. *Fundamentals of Horticulture*. Kalyani Publishers, Ludhiana.
17. Singh S S and Singh R. 2013. *Principles and practices of Agronomy*. Kalyani Publisher.
18. Sudheer K P and Indira V. 2016. *Post harvest Technology of Horticultural Crops*. New India Publishing Agency, New Delhi.

Introduction to Agricultural Engineering 4 (3+1)

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad.

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts.

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures.

Use of topographical survey and contour maps.

Different types of water harvesting structures.

Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components.

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures.

Classification of different types of agricultural commodities as durables, perishables, etc.; Moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements; Study of various types of biogas plants and operational parameters; Study of various solar energy application systems; Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump; Study of various post-harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Suggested Readings

1. Chakraverty A. 1999. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash S K, Bebartta J P and Kar. 2012. A. *Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Jain S C and Philip G. 2009. *Farm Machinery - An Approach*. Second Edition. Standard Publishers and Distributors, New Delhi.
4. Mal B C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers.
5. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. Jain Brothers, New Delhi.
6. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House New Delhi
7. Nakra C P. 1980. *Farm Machines and Equipment*. Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi.

8. Rai G D. 1995. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
9. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
10. Sahay K M and Singh K K. 1994. *Unit Operations of Agricultural Processing*. Vikas Publishing house Pvt. Ltd, New Delhi.
11. Suresh R and Kumar Sanjay. 2018. *Farm Power and Machinery Engineering*. Standard Publisher Distributors, New Delhi.
12. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.

Surveying and Levelling **3 (1+2)**

Objective

To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures

Theory

Surveying: introduction, classification and basic principles; Linear measurements, chain surveying, cross staff survey, compass survey, planimeter; Errors in measurements, their elimination and correction; Plane table surveying, methods, advantages and disadvantages.

Levelling, levelling difficulties and error in levelling, contouring, computation of area and volume.

Theodolite traversing, introduction to setting of curves; Total station, electronic theodolite; Introduction to GPS survey.

Practical

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Measurement of slope in the field; Study on contour and its characteristics; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by Theodolite; Height of object by using Theodolite; Setting out curves by Theodolite; Use of minor instruments; Use of total station, EDM in the field; Use of modern computers for surveying

Suggested Readings

1. Agor R. *A Text Book of Surveying & Levelling*. Khanna Publishers, New Delhi
2. Arora K R. 1990. *Surveying (Vol. I)*, Standard Book House, Delhi.
3. Kanetkar T P. 1993. *Surveying and Levelling*. Pune Vidyarthi Griha, Prakashan, Pune.
4. Punmia B C. 1987. *Surveying (Vol. I)*. Laxmi Publications, New Delhi.

Workshop Technology and Practice 2 (0+2)

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

Practical

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper; changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing

Suggested Readings

1. Chapman W A J. 2018. *Workshop Technology* (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. *Elements of Workshop Technology* (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. *A Text Book of Workshop Technology*. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. *A Course in Workshop Technology* (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

Basic Electrical Gadgets and Instruments 3 (2+1)

Objective

To enable the students to take up repair and maintenance of different common electrical gadgets and instruments.

Theory

Introduction to different electrical appliances used in agricultural buildings, structures and farm .0operations; Difference between AC and DC supply system; Introduction to AC fundamentals; AC

through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q-factor and bandwidth.

Three- phase AC circuit: Concept of balanced three-phase AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three phase power measurement like (one wattmeter and two –wattmeter method).

Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier and capacitive filter zener diode as voltage regulator.

Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods, fixed, self biasing and potential divider biasing method; OP-AMP, Ideal OP-AMP characteristics, Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator).

Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates, SOP rule and K-map), binary adder.

Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.

Practical

Basic Electrical and Electronics Gadgets

To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring); To prepare an electrical switch board to control two light points using two two-way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit; To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter; To measure the power consumption in a three-phase circuit using two-wattmeter method.

Instrumentation

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To verify different logic gates; To measure unknown resistance using Wheatstone bridge; To measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourdentube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing applications.

Suggested Readings

1. Boylestad R L and Nashelsky L N. 2011. *Electronic Device and Circuit Theory*. Pearson.

2. Ghosh S. 2007. *Fundamentals of Electrical and Electronics Engineering*. Second edition. PHI Learning, New Delhi.
3. Metha V K and Metha R. 2012. *Basic Electrical Engineering*. Fifth edition. S Chand & Co., New Delhi.
4. Metha V K and Metha R. 2012. *Principle of Electronics*. Fifth edition. S Chand & Co., New Delhi.
5. Rajput R K. 2007. *Basic Electrical and Electronics Engineering*. Laxmi Publications, New Delhi.
6. Theraja B L and Theraja A K. 2005. *A Text Book of Electrical Technology*. Vol. I & II. S Chand & Co., New Delhi.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objective

To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.

To provide basic knowledge of computer with applications in Agriculture and to make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (www): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in Agriculture; Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation; IT applications for computation of water and nutrient requirement of crops; Computer-controlled devices (automated systems) for Agri-input management; Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc.; Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information; Decision support systems: Concepts components and applications in agriculture; Agriculture Expert System; Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools; Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search;Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis,

automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA)

Suggested Readings

1. Choudhary K. R. Fundamentals of Artificial Intelligence. Springer
2. Date, C. J. 2000. Introduction to Database Management System. Addison-Wesley.
3. ITL Educations Solutions Ltd. Introduction to Information Technology. Pearson Education.
4. Kumar, E. 2020. Artificial Intelligence. Wiley.
5. Nilson, N.J. 2001. Principles of Artificial Intelligence. Narosa.
6. Rajaraman, V. and Adabala, N. Fundamentals of Computers. PHI Learning Pvt. Ltd, New Delhi.
7. Russell, Stuart. 2013. Artificial Intelligence: A Modern Approach. Pearson Edition.
8. Sethi, D. P. and Pradhan, M. 2017. Concepts and Techniques of Programming in C. I.K. International Publishing House Pvt. Limited.
9. Vanitha, G. 2023. Agro-Informatics. NIPA, New Delhi.

NCC- I 1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizens
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.

- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NSS- I **1(0+1)**

Objective

1. Evoking social consciousness among students through various activities, viz., working together, constructive, and creative social work
2. To be skilful in executing democratic leadership, developing skill in program
3. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.

- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Skill Enhancement **8 (0+8)**

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

i. Operation and maintenance of farm machinery
ii. Repair and maintenance of tractors and power tillers
iii. Management of agricultural machinery custom hiring and maintenance facilities
iv. Fabrication, operation and maintenance of renewable energy devices
v. Operation and maintenance of drones used for agricultural applications
vi. Machine vision, sensors and sensors architecture
vii. Design of solar PV system using softwares
viii. Installation and maintenance of on-grid and off-grid solar systems
ix. Design and maintenance of agri-voltaic systems
x. Valorization of agri-biomass and organic waste
xi. Energy audit, energy conservation and energy efficiency
xii. Repair and maintenance of pumps and irrigation systems
xiii. Installation and maintenance of micro-irrigation systems
xiv. Application of remote sensing and GIS for agricultural water management
xv. Operation and maintenance of hydro-meteorological instruments
xvi. Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well
xvii. Installation and maintenance of roof top rain water harvesting systems
xviii. Operation and maintenance of soil conservation structures
xix. Construction, management and maintenance of protected cultivation structures
xx. Agro processing methods, equipment operation and maintenance
xxi. Operation and management of multi-commodity agro-processing centre
xxii. Primary processing and value addition and cold chain logistics

xxiii. Food grain godown and warehouse management

xxiv. Post-harvest value chain management including logistics

After two to three days common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these skill areas. The selection of the module(s) will be entirely on the student's choice.

Indicative details of the skill enhancement modules are given at the end of this section. The credit hours for each module have been kept as 0+4. However, the institution is at liberty to modify the credit hours/ contents for the skill enhancement modules depending on the level of skill to be imparted to the students. For example, if a student wishes to take up three or four skill modules, the contents and credits can be modified for those skill modules, making the total 8 credits However, in no case, more than four modules are recommended for offering to a student.

It is emphasized that the purpose is to impart practical knowledge/ skill for operating the system and none of the course should be taken in theoretical mode. In specific cases, the skill enhancement in the specific area can be further continued during the 10 weeks' internship in case of exits for UG-certificate and UG-Diploma for further strengthening of the skill.

The above modules and details are indicative only and the institutions have the liberty to formulate new modules and modify the content of the modules relevant to the respective regions or even modify the titles of the above modules. It is advised that the institutions should define the detailed breakup of the skill areas depending on the facilities/ expertise available.

The course can also be offered in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners. The timetable for the remaining part of the semester will be adjusted accordingly as mentioned earlier.

Engineering Drawing 2 (0+2)

Objective

To enable the students to draw engineering drawings for some simple machines/ equipment

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, references planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional

representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints

Suggested Readings

1. Bhatt, N. D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt, N. D. and Panchal, V. M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana, K. L. and Kannaiah, P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd, Chennai.

Computer Programming and Data Structures 2 (0+2)

Objective

To make the students conversant on computer programming languages, specifically C language as well as to make him familiar with programming for simple agricultural engineering applications

Practical

Introduction to high level languages; Structure programming, C programming, a simple C programming, execution of a C program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Creating user defined functions; Developing structures and union; Using local, global and external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/ Deletion in queues.

Suggested Readings

1. Augenstein, L. and Tanenbaum. 2003. Data structures using C and C++. PHI/Pearson Education.
2. Balagurusamy, E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
3. Bronson, G. and Menconi, S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi.
4. Drozdek, A. 2012. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.

5. Goodrich, M T, Tamassia, R and Mount, D. 2011. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
6. Rajaraman, V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd, New Delhi.
7. Rajaraman, V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Sahni, S. 2006. Data Structures, Algorithms and Applications in C++. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
9. Weiss, M. A. 2007. Data Structures and Algorithm Analysis in C++. Pearson Education.
10. Agarwal, A. 2005. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

Farming based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture- based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar].
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.
4. Dixon, J. and Gulliver, A. with Gibbon, D. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Environmental Studies and Disaster Management 3 (2+1)

Objective

1. To expose and acquire knowledge on the environment
2. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. h. light pollution. Solid Waste Management: Classification of solid wastes and management methods,

Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bengaluru. 36 pp.
3. Erach Bharucha. Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi.
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur
6. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India.
7. Tyler, Miller and Spoolman, Scot. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication skill and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G. W. 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Dale, Carnegie. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar, S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James, W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998, Body Language. Sudha Publications, Delhi.
8. Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
9. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University

NCC-II 1 (0+1)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- II 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies

- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-II semester

Internship (only for exit option for award of UG-Certificate) 10 (0+10)

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and will be competent to start an enterprise.

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Engineering Mathematics-I 3 (3+0)

Objective

To make the students acquainted with the basic mathematics applied in engineering and their applications in solving engineering problems

Theory

Differential Equations: First order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation.

Higher order differential equations: Methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.

Partial differential equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Matrices: Elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem- its use to find inverse of the matrix, linear transformation, diagonalization of matrices.

Suggested Readings

1. Grewal, B. S. 2004. *Higher Engineering Mathematics*. Khanna Publishers Delhi.
2. Narayan, S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.

Engineering Physics 3 (2+1)

Objective

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Magnetism: Dia, para and ferro-magnetism- classification; Langrevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory; Introduction to quantum mechanics: wave particles duality, deBroglie concept uncertainty principle, time dependent and time independent Schrodinger equation.

Spectroscopy: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; Solid state physics: statement of Bloch function, bands in solids, effective mass, distinction between metals, insulators and semi-conductors.

Semiconductors: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; Superconductivity: super conductivity, critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, introduction to high T_c superconductors.

LASERS and MASERS: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; Holography and optical

fibre: optical fibre- physical structure, basic theory, type of modes, characteristics of optical fibre and applications; Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; Determine dielectric constant of material using De Sautys bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor using a p-n junction diode; Study the LCR circuit; Find the wave length of light by using prism and spectrometer; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Suggested Readings

1. Avadhanulu, M. N. 2013. *An Introduction to Lasers theory and applications*. S. Chand Publication.
2. Chattopadhyay, D. and Rakshit, P. C. 2011. *Electricity and Magnetism*. S. Chand Publication.
3. Ghatak, A. K. and Lokanathan, S. 2022. *Quantum Mechanics*, *Theory and Application*. Trinity Press.
4. Griffiths, D. J. and Schroeter. 2018. *Introduction to Quantum Mechanics*. Cambridge University Press.
5. Khandelwal, D. P. 1985. *A Laboratory Manual of Physics*. Vani Publications.
6. Kittel, C. 2005. *Introduction to Solid State Physics*. Wiley Eastern Pvt. Ltd.
7. Laud, B. B. 2011. *Lasers and Non-linear Optics*. New Age International Publishers.
8. Mani, H. S. and Mehta, G. K. 2022. *Modern Physics*. Affiliated East-West Press.
9. Omar, M. A. 2002. *Elementary Solid State Physics*. Pearson.
10. Prakash, S. 2011. Optics. *Pragati Prakashan*, Meerut.
11. Saraf, B. and Khandelwal, D. P. 1982. *Physics through Experiments.* Vol. I & II. Vikas Publication, New Delhi.
12. Subramanyam, N., Lal, B. and Avadhanulu, M. N. 2012. *A Textbook of Optics*. S. Chand.
13. White, H. E. 2019. *Introduction to Atomic Spectra*. Mc-Graw Hill Publication.
14. Worsnop, B. L. and Flint, H. C. 1951. *Advanced Practical Physics*. Littlehampton Book Services Ltd.

Engineering Chemistry 3 (2+1)Objective

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule: Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb.

Colloids: Classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis, causes, types and methods of prevention- proper designing.

Corrosion: Cathodic protection using pure metal and metal alloys, use of inhibitors.

Water: Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion, basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating.

Fuels: Classifications, calorific value and its determination by bomb calorimeter.

Principles of food chemistry: Lipids, proteins, carbohydrates and their classifications, vitamins and their importance.

Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method.

Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavoring reagents of foods.

Lubricants: Classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability.

Type of polymerization with examples (addition, free radical); Different properties of polymers-chemical resistance, crystallinity.

Polymers: Effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles of determination of molecular weight by light scattering methods.

Introduction to IR spectroscopy: Basic principles of spectroscopy, Beer-Lambarts law, types of vibration, symmetric, asymmetric vibration and it type, absorbances of different functional group in IR.

Practical

To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; To study the different types of food preservatives and their active principles; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To estimate chloride in water samples; To study the different properties of lubricants; To determine λ_{max} and verification of Beer-Lambert law.

Suggested Readings

1. Bahl, B. S., Bahl, A. and Tuli, B. D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd, Delhi.
2. Finar, I. L. 2002. *Organic Chemistry*. Vol I and II. Pearson.
3. Glasstone, S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.

4. Jain and Jain. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
5. Jain, P. L. and Jain, M. 1994. *Engineering Chemistry*. Danpat Rai publishing company Pvt. Ltd, Delhi.
6. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. 2010. *Organic Chemistry*. Pearson.
7. Sharam, Y. R. 2013. *Elementary Organic Spectroscopy*. S Chand.

Engineering Mechanics 3 (2+1)

Objective

To make the students acquainted with the principles of engineering mechanics and the calculation of different stresses to be helpful for design of engineering structures

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units.

Composition and resolution of forces, analytical method, graphical method.

Laws of forces, moments and their application, levers, parallel forces and couples.

Equilibrium of forces, free body diagrams.

Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections.

Moment of inertia: Methods of finding out M.I., methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections.

Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack.

Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads.

Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems.

Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexture.

Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft.

Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas;

Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

Suggested Readings

1. Bansal, R. K. 2005. *A Text Book of Engineering Mechanics*. Laxmi Publishers, New Delhi.
2. Khurmi, R. S. 2006. *Strength of Materials*. S. Chand Publishing.
3. Khurmi, R. S. 2018. *A Text Book of Engineering Mechanics*. S. Chand Publishing.
4. Prasad, I. B. 2004. *Applied Mechanics and Strength of Materials*. Khanna Publishers, New Delhi.
5. Prasad, I. B. 2004. *Applied Mechanics*. Khanna Publishers, New Delhi.
6. Sundarajan, V. 2002. *Engineering Mechanics and Dynamics*. Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Timoshenko, S. and Young, D. H. 2003. *Engineering Mechanics*. McGraw Hill Book Co., New Delhi.

Soil Mechanics 2 (1+1)

Objective

To make the students acquainted with the principles of soil mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures

Theory

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit; Classification of soils, effective and neutral stress, Boussinesq and Westerguard's analysis, New-mark's influence chart, stress distribution and diagrams.

Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, triangle test and vane shear test. Numerical exercise based on various types of tests.

Compaction of soils, standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one-dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method.

Earth pressure: Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises; Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method.

Practical

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Casagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test.

Suggested Readings

1. Punmia, B. C., Jain, A. K. and Jain, A. K. 2005. *Soil Mechanics and Foundations*. Laxmi Publications (P) Ltd. New Delhi.
2. Ranjan, G. and Rao, A. S. R. 1993. *Basic and Applied Soil Mechanics*. Welley Easters Ltd., New Delhi.
3. Singh, A. 1994. *Soil Engineering*. Vol. I. CBS Publishers and Distributions, Delhi.

Fluid Mechanics and Open Channel Hydraulics 3 (2+1)

Objective

To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

Theory

Properties of fluids: Ideal and real fluid, units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies.

Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon.

Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe.

Laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes.

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter.

Dimensional analysis and similitude: Rayleigh's method and Buckingham's `pi' theorem, types of similarities, dimensionless numbers; Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow; Determination of meta-centric height; Verification of Bernoulli's theorem, determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter; Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froude's number and Reynold's number; Study of various types of pumps and its components.

Suggested Reading

1. Bansal, R. K. 2019. *A Text book of Fluid Mechanics*. Laxmi Publications, New Delhi.
2. Ramanuthan, S. 2011. *Hydraulics, Fluid Mechanics & Hydraulic Machines*. Dhanpat Rai & Sons, Delhi.
3. Khurmi, R. S. and Khurmi, N. 1987. *Hydraulics, Fluid Mechanics and Hydraulic Machines*. S. Chand & Co. Ltd., New Delhi.
4. Modi, P. N. and Seth, S. M. 2017. *Hydraulics & Fluid Mechanics including Hydraulic Machines*. Standard Book House, Delhi.

Engineering Properties of Agricultural Produce and Food Science 3 (2+1)

Objective

To make the students acquainted with the different engineering properties of agricultural produce and to help them understand the importance of these properties in handling, processing and storage

Theory

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.

Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.

Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods.

Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques.

Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.

Practical

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

Suggested Readings

1. Mohesin, N. N. 1980. *Physical Properties of Plants & Animals*. Gordon & Breach Science Publishers, New York.
2. Rao, M. A. and Rizvi, S. H. 1995. *Engineering Properties of Foods*. Marcel Dekker Inc. New York.
3. Serpil, S. and Servet, G. S. 2005. *Physical Properties of Foods*. Springer Science+Business Media, LLC, 233 Spring Street, New York.
4. Singhal, O. P. and Samuel, D. V. K. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan, New Delhi.

Farm Machinery and Equipment- I 3 (2+1)

Objective

To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc., and their economics of operation

Theory

Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.

Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.

Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation.

Testing and Evaluation of tillage and sowing equipment and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors.
3. Lal, Radhey and Datta, A. C. 1978. *Agricultural Engineering through worked out examples*. Saroj Prakashan, Allahabad.

4. Nakra, C. P. 2003. *Farm Machines and Equipment*. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. *Farm Machinery and Equipment*. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. *Elements of Farm Machinery*. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. *A Work Book on Practical Farm Machinery* (Vol. I and II). Saroj Prakashan, Allahabad.

Physical Education, First Aid, Yoga Practice and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga

- Asanas: Definition and Importance, Padmasan, Gaumukhasan, hadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester IV

Engineering Mathematics-II 3 (3+0)

Objective

To make the students acquainted with the application of various advanced mathematics such as vector calculus, Fourier series and Laplace transform and applications of numerical methods in engineering

Theory

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs), functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half range series expansion, series expansion of functions with finite discontinuity; Laplace Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations.

Numerical methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four.

Suggested Readings

1. Grewal, B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers Delhi.
2. Narayan, S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. *Differential Calculus*. S. Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.

Ramana, B. V. 2008. *Engineering Mathematics*. Tata McGraw-Hill, New Delhi.

Theory of Structures 2 (1+1)

Objectives

To make the students acquainted with the principles of structural design and to enable them to design small and medium RCC and steel structures

Theory

Types of Load and use of BIS code

Design of steel structures: Specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, ETABS, etc. for design of roof truss.

Design of RCC structures: Specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two-way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures.

Practical

Design and drawing of steel roof truss including tension member, compression member, and member under bending; use of design softwares; Design and drawing of RCC building, including single reinforced beam, double reinforced beam, one-way slab, two-way slabs, columns and foundations; use of design softwares for simple RCC structures.

Suggested Readings

1. Bhavikatti, S. S. 2014. *Design of Steel Structures: By Limit State Method as Per IS: 800-2007*. I K International Publishing House Pvt. Ltd.
2. Duggal, S. K. 2017. *Limit State Design of Steel Structures*. McGraw Hill Education.
3. Punmia, B. C., Jain, A. K. and Jain, A. K. 2016. *Limit State Design of Reinforced Concrete*. Laxmi Publications.
4. Raju, N. K. 2019. *Design of Reinforced Concrete Structures: IS:456-2000*. CBS Publishers & Distributors.

Building Construction and Cost Estimation 2 (2+0)

Objective

To make the students acquainted with the methods of construction of agricultural buildings and to enable them to prepare various types of estimates of buildings

Theory

Building materials: Description of important building materials, rocks, different stones; formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades.

Concrete: Grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials.

Building construction: Building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and waterproofing,

white washing, distempering and painting, steps for building construction, needs of different agricultural buildings, types and uses, types of roofs, slope and flat roof buildings.

Estimating and costing: Types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development.

Cost economics: Measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period).

Suggested Readings

1. Duggal, S. K. 2012. *Building Material*. New Age International Publishers.
2. Dutta, B. N. 2000. *Estimating and Costing*. UBS publishers.
3. Punmia, B. C., Jain, A. K. and Jain, A. K. 1984. *Building Construction*. Laxmi Publications (P) Ltd., New Delhi.
4. Rangwala, S. C. 1994. *Engineering Materials*. Charotar Publishing House, Anand.
5. Sane, Y. S. 1964. *Planning and Designing of Buildings*. Engineering Book Publishing Co. Pune.

Watershed Hydrology 3 (2+1)

Objective

To make the students acquainted with the different hydrological processes, their methods of analysis so as to enable them to apply these for watershed development, water harvesting, minor irrigation, drought and flood control, etc.

Theory

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges.

Frequency analysis of point rainfall; Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship.

Hydrologic processes- interception, infiltration -factors influencing, measurement and indices; Evaporation- estimation and measurement; Runoff- factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, rational method, Cook's method and SCS curve number method.

Geomorphology of watersheds – linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency; Hydrograph - components, base flow separation, unit hydrograph theory, s-curve, synthetic hydrograph, applications and limitations.

Flood routing – channel and reservoir routing; Hydrology of dry land areas, Troll's climatic classification; Drought- classification, causes and impacts, drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves; Study of depth - area – duration

curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records; Computation of infiltration indices; Computation of peak runoff and runoff volume by Cook's method and rational formula; Computation of runoff volume by SCS curve number method; Study of stream gauging instruments- current meter and stage level recorder; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow ; Study of unit hydrograph; Study of synthetic hydrograph; Study of flood routing; Study of various discharge measuring devices.

Suggested Readings

1. Chow, V. T., Maidment, D. R. and Mays, L. W. 2010. *Applied Hydrology*. McGraw Hill, New York.
2. Das, G. 2000. *Hydrology and Soil Conservation Engineering*. PHI, New Delhi.
3. Garg, S. K. 1998. *Hydrology and Water Resources Engineering*. Khanna Publishers, Delhi.
4. Jaya Rami Reddy, P. 2011. *A Text Book of Hydrology*. University Science Press, New Delhi.
5. Linsley, R. K., Kohler, M. A., and Paulhus, J. L. H. 1984. *Hydrology for Engineers*. McGraw-Hill Publishing Co., Japan.
6. Mutreja, K. N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., New Delhi.
7. Panigrahi, B. and Panigrahi, K. 2016. *Engineering Hydrology*. New India Publishing Agency, New Delhi.
8. Raghunath, H. M. 2006. *Hydrology: Principles Analysis and Design*. 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
9. Subramanya, K. 2008. *Engineering Hydrology*. 3rd Edition, Tata McGraw-Hill, New Delhi.
10. Suresh, R. 2005. *Watershed Hydrology*. Standard Publishers and Distributors, Delhi.
11. Varshney, R. S. 1986. *Engineering Hydrology*. Nem Chand and Brothers, Roorkee, U.P.

Soil and Water Conservation Engineering 3 (2+1)

Objective

To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation

Theory

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion.

Water erosion: Mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>25 and EI_{30} methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

Water erosion control measures: Agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and

graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump.

Soil erosion control structures- Introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

Wind erosion: Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.

Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

Water harvesting techniques: Classification based on source, storage and use, runoff harvesting-short-term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds.

Practical

Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation; Determination of length of slope (LS) and cropping practice (CP) factors; Estimation/measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor; Determination of sediment concentration through oven drying method. Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs; Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond- design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed.

Suggested Readings

1. Chow, V. T. 1985. *Open-Channel Hydraulics*. McGraw- Hill Book Company, Inc.
2. Frevert, R. K., Schwab, G. O., Edminster, T. W. and Barnes, K. K. 2009. *Soil and Water Conservation Engineering*. 4th Edition, John Wiley and Sons, New York.
3. Mahnot, S. C. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service, New Delhi.

4. Mal, B. C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers.
5. Michael, A. M. and Ojha, T. P. 2003. *Principles of Agricultural Engineering*. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Murthy, V. V. N. 2002. *Land and Water Management Engineering*. 4th Edition, Kalyani Publishers, New Delhi.
7. Norman Hudson. 1985. *Soil Conservation*. Cornell University Press, Ithaka, New York, USA.
8. Samra, J. S., Sharda, V. N. and Sikka, A. K. 2002. *Water Harvesting and Recycling: Indian Experiences*. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
9. Sharda, V. N., Juyal, G. P., Prakash, C. and Joshi, B. P. 2007. *Training Manual: Soil Conservation and Watershed Management* (Vol.-II) – CSWCRTI Publication, Dehradun.
10. Singh, G., Venkataraman, C., Sastry, G. and Joshi, B. P. 1996. *Manual of Soil and Water Conservation Practices*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
11. Suresh, R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.
12. Das, G. 2000. *Hydrology and Soil Conservation Engineering*. Prentice Hall of India Pvt. Ltd, New Delhi.
13. USDA. 1964. *Engineering Hand Book on Drop Spillways (Section-11)*. USDA, Soil Conservation Service.

Farm Machinery and Equipment II — 3 (2+1)

Objective

To make the students acquainted with the basic construction and operational features, and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines, etc.

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Harvesting of crops: Harvesting methods, harvesting terminology; Mowers– types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay.

Threshing: manual and mechanical systems; Types of threshing drums and their applications; Types of threshers- tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine

troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details.

Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting-cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.

Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and interculture equipment; Study of sprayers-types, functional components, calibration; Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator; Familiarization with manual and powered weeding equipment and identification of functional components; Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters; Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of functional units of grain combines and their types, calculations for grain losses in a combine; Study of root crop diggers and familiarization with the functional units and attachments; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations various machines; Visit to implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A. C. 1978. *Agricultural Engineering through Worked Out Examples*. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. *Farm Machines and Equipment*. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. *Farm Machinery and Equipment*. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. *Elements of Farm Machinery*. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. *A work Book on Practical Farm Machinery*. Vol. I and II. Saroj Prakashan, Allahabad
9. Suresh, R. and Kumar, S. 2018. *Farm Power and Machinery Engineering*. Standard Publishers.

Renewable Energy Sources 3 (2+1)

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations

Theory

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources.

Solar energy: Energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system; Solar photo voltaics- basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station; Calculation of energy through photovoltaic power generation and cost economics.

Wind energy: Energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system.

Biogas: Basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design and use of different commercial biogas plants.

Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification and Dendro-thermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Suggested Readings

1. Basu, P. 2018. *Biomass Gasification and Pyrolysis Practical Design and Theory*. Academic Press.
2. Deublein, D. and Steinhauser, A. 2008. *Biogas from Waste and Renewable Resources*. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

3. Duffie, J. A. and Beckman, W. A. 2013. *Solar Engineering of Thermal Process*. John Wiley and Sons.
4. Julian Chen, C. 2011. *Physics of Solar Energy*. John Wiley & Sons, Inc.
5. Khan, B. H. 2006. *Non-Conventional Energy Resources*. The McGraw Hill Publishers.
6. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press.
7. Patel, M. R. 2005. *Wind and Solar Power Systems*. CRC Press, Bota Racon.
8. Rai, G. D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
9. Rai, G. D. 2020. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
10. Reed, T. B. and Das, A. 1988. *Handbook of Biomass Downdraft Gassifier Engine Systems*. SERI, USA.
11. Ryszard, Petela. 2010. *Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization*. The McGraw-Hill Companies.
12. Stefan, C. W. and Krauter. 2008. *Solar Electric Power Generation – Photovoltaic Energy Systems*. Springer.

Post-Harvest Engineering of Cereals, Pulses and Oilseeds 3 (2+1)

Objective

To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds, and the different equipment for the operations

Theory

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds.

Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down.

Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating.

Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

Practical

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant; Determination of EMC (static and dynamic method); Study of psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

Suggested Readings

1. Chakraverty, A. 1999. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH publishing Co. Ltd, New Delhi.
2. Dash, S. K., Bebartta, J. P. and Kar, A. 2012. *Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Geankoplis, C. J. 2002. *Transport Processes and Unit Operations*. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Mangaraj, S., Dash, S. K., Swain, S. and Ali, N. 2016. *Agricultural Process Engineering*. Vol II. Kalyani Publishers, New Delhi.
5. McCabe, W. L., Smith, J. C. and Harriott, P. 1993. *Unit Operations of Chemical Engineering*. McGraw Hill.
6. Sahay, K. M. and Singh, K. K. 1994. *Unit Operations of Agricultural Processing*. Vikas Publishing House Pvt. Ltd, New Delhi.
7. Swain, S., Dash, S. K., Mangaraj, S. and Ali, N. 2016. *Agricultural Process Engineering*. Vol I. Kalyani Publishers, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objective

1. To provide the student an insight into the concept and scope of entrepreneurship
2. To expose to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

- Charantimath, P.M. 2009. *Entrepreneurship Development and Small Business Enterprises*. Pearson Publications, New Delhi.
- Desai, V. 2015. *Entrepreneurship: Development and Management*. Himalaya Publishing House.
- Desai, V.1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House
- Grover, Indu. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
- Gupta, C.B. 2001. *Management Theory and Practice*. Sultan Chand & Sons.
- Khanka, S. S. 1999. *Entrepreneurial Development*. S. Chand & Co.
- Mehra, P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
- Pandey, M. and Tewari, D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
- Singh, D. 1995. *Effective Managerial Leadership.* Deep & Deep Publ.
- Singhal, R.K. 2013. *Entrepreneurship Development and Management*. Katson Books.
- Tripathi, P. C. and Reddy, P. N. 1991. *Principles of Management*. Tata McGraw Hill.

Post-IV semester

Internship (only for exit option for award of UG-Diploma) 10 weeks **10 (0+10)**

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-Diploma, they will be able to get proper engagement/ employment and will be competent to start an enterprise

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

Semester V

Strength of Materials **2 (1+1)**

Objective

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

Introduction to strength of materials.

Slope and deflection of beams: Slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection.

Theory of columns and struts, problems of column and struts.

Steel connections: Analysis of rivet connections, analysis of welded connections.

Stability analysis of masonry dam; problems on masonry dam.

Statically indeterminate structures- analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three moment equation.

Analysis of beam using moment distribution method and solving problems.

Practical

To determine the quality of check of two different aggregates through impact test; To perform the tensile test of steel specimen - to observe the behaviour of materials under load - to calculate the value of e- ultimate stress, permissible stress, percentage elongation etc. And to study its fracture; To prepare mortar specimen of different cement, demoulding of the specimen next day for compression and tension test after 2nd and 4th week; To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2nd and 4th week; To perform compression and tension test on mortar specimen prepared 2 weeks before; To perform compression and bending test of the concrete specimen prepared 2 weeks before; To perform compression and tension test on mortar specimen prepared 4 weeks before; To perform compression and bending test of the concrete specimen prepared 4 weeks before; To determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points; To perform Brinell's hardness tests on a given specimen; To study the behaviour of materials under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Suggested Readings

1. Junarkar, S. B. 2001. *Mechanics of Structures* (Vo-I). Choratar Publishing House, Anand.
2. Khurmi, R. S. 2006. *Strength of Materials*. S. Chand Publishing, New Delhi.
3. Lehri, R. S. and Leheri, R. S. 2006. *Strength of Materials*. S.K. Kataria & Sons, New Delhi.
4. Ramamrutham, S. and Narayanan, R. 2003. *Strengths of Materials*. Dhanpat Rai and Sons, Nai Sarak, New Delhi.
5. Vazirani, V. N., Ratawani, M. M. and Duggal, S. K. 2012. *Analysis of Structures*. Khanna Publishers, New Delhi.

Theory of Machines 2 (2+0)

Objective

1. To enable the students to analyse the relative motion between various parts of machine and forces which act on them
2. To apply the theories in designing the various parts of the machine

Theory

Simple mechanism: Elements, links, pairs, kinematics chain, and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain, slider crank chain and their inversions; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method.

Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method.

Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications.

Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; chain drives, classification of chain drive, terms used in chain drive.

Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.

Static and dynamic balancing, balancing of rotating masses in one and different planes.

Suggested Readings

1. Ballaney, P. L. 2016. *A Text Book of Theory of Machines*. Khanna Publishers, New Delhi.
2. Bansal, R. K. 2009. *A Text Book of Theory of Machines*. Laxmi Publications (P) Ltd., New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2010. *A Text Book of Theory of Machines*. Euresia Publishing House (P) Ltd, New Delhi.
4. Ratan, S. S. 2010. *A Text Book of Theory of Machines*. Tata McGraw Hill Publishing Company Ltd, New Delhi.

Thermodynamics and Heat Transfer 3 (3+0)

Objective

1. To make the students acquainted with principles of thermodynamics and heat transfer
2. To make them understand the mathematical and practical aspects of heat exchangers

Theory

Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems- thermodynamic equilibrium, properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat.

First law of thermodynamics: internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1; characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion and throttling process; Second law of thermodynamics: limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics; Clausius statement, Kelvin-Planck statement; perpetual motion machine of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.

Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection,

non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection.

Thermal radiation, black body radiation, Stefan-Boltzman law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity.

Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.

Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Suggested Readings

1. Gupta, C. P. and Prakash, R. 2008. *Engineering Heat Transfer*. Nem Chand and Bros., Roorkee.
2. Holman, J. P. 2018. *Heat Transfer*. McGraw Hill Book Co., New Delhi.
3. Incropera, F. P. and De Witt, D. P. 2016. *Fundamentals of Heat and Mass Transfer*. John Wiley and Sons, New York.
4. Kumar, D. S. 2016. *Engineering Thermodynamics*. S.K. Kataria & Sons, Delhi.
5. Rajput, R. K. 2019. *A Text Book of Heat and Mass Transfer*. S. Chand & Company Ltd., New Delhi.

Tractor and Automotive Engines 3 (2+1)

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines.

Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies.

Study of engine components their construction, operating principles and functions; Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area.

Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio.

Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system-injection pump, their types, working principles; Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics; Lubrication

system- need, types, functional components; Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency.

Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator; Basics of engine testing.

Practical

Study of different systems of CI engines; Study of engine parts and functions, working principles, etc.; Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system, and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical system; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

1. Ganesan, V. 1999. *Internal Combustion Engines*. Mc Graw Hill, New Delhi.
2. Goering, C. E. and Hansen, A. C. 2004. *Engine and Tractor Power*. ASAE. St Joseph, Michigan.
3. Heitner, J. 2004. *Automotive Mechanics: Principles and Practices*. CBS Publishers.
4. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 1989. *Tractors and Their Power Units*. Van Nostrand Rainhold, New York.
5. Mathur, M. L. and Sharma, R. P. 1996. *A course in Internal Combustion Engines*. Dhanpat Rai and Sons, New Delhi.
6. Rodichev, V. and Rodicheva, G. 1984. *Tractors and Automobiles*. Mir Publishers, Moscow.
7. Singh, K. 2020. *Automobile Engineering.* Vol II. Standard Publishers and Distributors.

Irrigation and Drainage Engineering 4 (3+1)

Objective

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods.

Design and lining of irrigation field channels, on-farm structures for water conveyance, control and distribution; Underground pipe conveyance system: components and design; land grading; Criteria for land levelling, land levelling design methods.

Soil-water-plant relationship: Soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants,

measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies.

Surface methods of water application: Border, check basin and furrow irrigation- adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient.

Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations; Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope; Layout, construction and installation of drains; Drainage structures, vertical drainage, bio-drainage, tile drains, mole drain.

Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practical

Measurement of soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method; Study on *in-situ* measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and sub-surface drainage system; Visit to a waterlogged area and study of a drainage project.

Suggested Readings

1. Allen, R. G., Pereira, L. S., Raes, D. and Smith, M. 1998. *Crop Evapotranspiration Guidelines for Computing Crop Water Requirement*. Irrigation and drainage paper 56, FAO of United Nations, Rome.
2. Bhattacharya, A. K. *Drainage Engineering*. ICAR Publications, New Delhi.
3. Bhattacharya, A. K. and Michael, A. M. 2013. *Land Drainage, Principles, Methods and Applications*. Vikas Publication House, Noida (UP).
4. Israelsen, O. W., Hansen, V. E. and Stringham, G. E. 1980. *Irrigation Principles and Practices*. John Wiley & Sons, Inc. USA.
5. Majumdar, D. K. 2013. *Irrigation Water Management Principles*. PHI learning Private Limited, New Delhi.
6. Michael, A. M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
7. Michael, A. M. and Ojha, T. P. 2014. *Principles of Agricultural Engineering.* Vol II. 5th Edition.

Jain Brothers Publication, New Delhi.

8. Murthy, V. V. N. 2013. *Land and water Management Engineering*. Kalyani Publishers, New Delhi.
9. Panigrahi, B. 2013. *A Handbook on Irrigation and Drainage*. New India Publishing Agency, New Delhi.
10. Ritzema, H. P. 1994. *Drainage Principles and Applications*. ILRI Publication 16.

Food and Dairy Engineering 4 (3+1)

Objective

1. To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products
2. To make them understand the different types of equipment and their working principles used for these.

Theory

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance.

Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: thermo-bacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing.

Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating.

Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.

Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.

Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling

by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles.

Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

Practical

Preparation of flow charts for different food processing industries; Study of different parts of retort and canning process; Study of different types of evaporators and multiple effect evaporation system; Study of drum dryer and spray dryer and comparison of product qualities; Study of different types of mixers for solids and liquids; determination of mixing effectiveness and mixing index; Study of settling and sedimentation process in a tank; Study of different types of filters; Study of membrane modules and different types of membranes; Study of measurement of different properties of milk and milk products; Study of milk pasteurizer, sterilizer and homogenizer; Study on preparation of cream and butter; Study of preparation of cheese, paneer and ice cream; Study of different types of packaging materials; Study of different types of filling machines for liquids and powder/ granules; Study of layout of a food processing plant; Visit to food processing industries and dairy plants to study the plant layout and unit operations.

Suggested Readings

1. Ahmed, T. 1997. *Dairy Plant Engineering and Management*. Kitab Mahal.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
3. McCabe, W. L., Smith, J. C. and Harriott. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
4. Rao, D. G. 2009. *Fundamentals of Food Engineering*. PHI learning Pvt. Ltd, New Delhi.
5. Singh, R. P. and Heldman, D. R. 1993. *Introduction to Food Engineering*. Academic Press.
6. Toledo, R. T. 1997. *Fundamentals of Food Process Engineering*. CBS Publishers

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback.

Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir. 1988. *How to Succeed at Interviews*. Tata McGraw-Hill.
2. Heller, Robert. 2002. *Effective Leadership. Essential Manager series*. Dk Publishing.
3. Hindle, Tim. 2003. *Reducing Stress. Essential Manager series*. Dk Publishing.
4. Lucas, Stephen. 2001. *Art of Public Speaking*. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J. 2004. *Power of Positive Thinking.* Delhi. Rohan Book Company.
6. Kumar, Pravesh. 2005. *All about Self- Motivation.* New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. *Body Language*. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

Seminar **1 (0+1)**

Objective

1. To enable students to improve their knowledge and understanding of a topic
2. To develop confidence and competence to identify and compare technical and practical issues related to the area of course specialization and to present it before a group of people

Practical

The student will be assigned to present on a technical and practical issue or on an emerging field. The activities should include establishing motivation for any topic of interest and develop a thought process for technical presentation, conduct a detailed literature survey and to build a document with respect to technical publications, analysis and comprehension of proof-of-concept and related data, and effective presentation with improved soft skills. It should also involve use of new and recent technologies for creating technical reports and presentation. The evaluation shall be based on the ability of the student to describe, interpret and analyze technical issues and competence in presenting.

Study tour **2 (0+2) NG**

The study tour will be of 10-14 days duration within the 5th semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organisations/ industries (related to the profession), they will also be exposed to the geographical, social, socio-economic and cultural diversity of different places/ states. After the visit, the students will submit a report/ make a presentation.

Semester VI

Tractor Systems and Controls 3 (2+1)

Objective

1. To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems
2. To understand the ergonomical and safety considerations in tractor

Theory

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements.

Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers.

Suggested Readings

1. Barger, E. L., Liljedahl, J. B. and McKibben, E. C. 1967. *Tractor and their Power Units*. Wiley Eastern.
2. BIS Test codes for tractor.

3. Giri, N. K. 2013. *Automobile Mechanics (SI Units)*. Khanna Publishers, Delhi.
4. Jain, S. C. and Rai, C. R. 2013. *Farm Tractor, Maintenance and Repair*. Standard Publisher and Distributers, Delhi.
5. Singh, K. 2020. *Automobile Engineering*. Standard Publisher and Distributers, Delhi.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Michigan.

Groundwater, Wells and Pumps 3 (2+1)

Objective

To make the students acquainted with the quality of ground water, equipment and methods for construction of wells, and different types of water lifting devices

Theory

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of groundwater, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells.

Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells.

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise groundwater development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of groundwater.

Quality of groundwater, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water.

Pumping systems: Water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method; Design of well; Study of well

losses and well efficiency; Determination of safe yield by Hill's method; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of groundwater balance; Study of various artificial ground- water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site; Visit to a groundwater project and a river lift project.

Suggested Readings

1. Garg, S. P. 1987. *Groundwater and Tube Wells*. Oxford & IBH Publishing Co. Ltd., New Delhi.
2. Lal, R. 1993. *Irrigation Hydraulics*. Ajiwan Shiksha Sansthan, Allahabad.
3. Michael, A. M., Khepar, S. D. and Sondhi, S. K. 2008. *Water Well & Pump Engineering*. Tata Mc-Graw Hill.
4. Nagabhusaniah, H. S. 2020. *Groundwater in Hydrosphere*. CBS Publishers and Distributors, New Delhi.
5. Raghunath, H. M. 2007. *Groundwater*. New Age Publications, New Delhi.
6. Todd, D. K. and Mays, L. W. 2011. *Groundwater Hydrology*. John Wiley & Sons, New York.

Sensors, Artificial Intelligence and Robotics in Agriculture 3 (2+1)

Objective

To enable the student to know the

1. Basics and selection of sensors for different agricultural applications
2. Application of artificial intelligence and AI programming techniques
3. Problem-solving through search and knowledge representation and reasoning with AI
4. Use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm and basics on neural network

Sensors Fundamentals: Introduction to sensors and transducers; Need for sensors in the agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect- Magneto mechanical effect (magnetostriction) – Magneto resistive effect.

Basics of detector materials/ sensor type (Silicon diod, InGaAS- etc.) and their characteristics. Fundamentals of visual, NIR, IR and FTIR spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results.

Sensors in different applications: Occupancy and motion detectors; Position, displacement, and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature sensors, Optical sensors and electromagnetic wave detector.

Capacitance sensors; Weather sensors, imaging sensors and their application in agriculture.

Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor etc.

Biosensors, general components of biosensor, biomolecules in biosensors such as enzyme, DNA, antibody, Nanomaterials in biosensors- Quantum dots.

Selection of sensors:

Introduction to Artificial Intelligence: *Overview*- foundations, scope, problems, history and approaches of AI. Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, AI programming techniques. Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining; Advantages and limitations of AI systems.

Problem-solving through Search: Forward and backward, state-space, blind, heuristic, problem reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, bidirectional search, heuristic search, problems and examples.

Knowledge Representation and Reasoning: Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graphs.

Robotics: Introduction to Robotics-classification with respect to geometrical configuration (anatomy), selection based on the agriculture application; Hardware for robot, sensors and actuator in robot, control of robot, system interface and integration in robot; Communication- internal and external communications; Fundamentals of microprocessor architecture; Introduction to use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm-basic on neural network; Feedback system, safety sensors; Controlled system and chain type: Serial manipulator and Parallel Manipulator. Components of Industrial robotics-precession of movement-resolution, accuracy and Repeatability-Dynamic characteristics- speed of motion, load carrying capacity and speed of response.

Application in Agriculture: Introduction to precision farming tools for implementation of precision agriculture; Application of site-specific management - nutrient management, agro-chemicals and fertilizer management, weeds management; Application of drone- pesticides/ nutrient spraying, environmental monitoring; Yield monitoring and mapping, soil sampling and analysis; Protected cultivation - smart irrigation system; precision livestock farming, application in food processing; image processing- shape analysis, feature detection and object location; gas and chemical sensor for electronic nose and electronic tongue.

Practical

Identify various sensors viz. Proximity sensors, ultrasonic sensors, optical sensors, electrochemical sensors and mechanical sensors; Measurement of displacement, force and pressure using different sensors; Use of load sensor on tractors to predict pulling requirements for ground engaging equipment; Introduction to open source programming languages, advantages and drawbacks of open source programming; Programming in Embedded- C, Concepts of C language; Identify various components in open source hardware (arduino and raspberry pi); Using of open source hardware and program for LED blink; Using of open source hardware and program for buzzer; Measurement of distance using ultrasonic sensor and IR sensor using open source hardware and programs; Experiment using moisture, temperature and relative humidity sensors for automatic

irrigation and protected cultivation; Detection based spraying system using ultrasound for spraying operation using opens source hardware by programming with sensor and testing; Detection based spraying system using ultrasound for spraying operation – installation on sprayer unit with actuator/sensor and testing; Learning on open source image processing software for shape analysis and object detection; Learning about the different applications of robots in agriculture; Fabrication and integration of sensors; Visit to robot fabrication facilities/workshop.

Suggested Readings

1. Bräunl, T. 2013. *Embedded Robotics Mobile Robot Design and Applications with Embedded Systems*. Springer Berlin Heidelberg.
2. Craig John, J. 2005. *Introduction to Robotics*. Pearson Education Inc., Asia, 3rd Edition.
3. Ghoshal, Asitava. 2006. *Robotics: Fundamental Concepts and Analysis*. Oxford University Press.
4. Gonzalez and Wintz. *Digital Image Processing*. 3rd edn.
5. Jha, S. N. 2015. *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*. Elsevier, USA (ISBN 9780124200845), p266.
6. Jha, S. N. (ed.). 2010. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer – Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3-642-15796-7: 288p.
7. Nikku, S. B. 2020. *Introduction to Robotics – Analysis, Control, Applications*. 3rd edition. John Wiley & Sons Ltd., 2020.
8. Nilsson Nils, J. 1980. *Principles of Artificial Intelligence*. Elsevier.
9. Rich, Knight and Nair. *Artificial Intelligence*. Tata McGraw Hill.
10. Saha, S. K. 2014. *Introduction to Robotics*. Tata McGraw Hills Education, 2014.
11. Schilling Robert, J. 1990. *Fundamentals of robotics – Analysis and control*. Prentice Hall of India.

Agricultural Structures and Environment Control 3 (2+1)

Objective

1. To make the students acquainted with the different types of agricultural structures
2. To enable them to prepare plan and estimate for different farm structures and environment control measures.

Theory

Farm and farmstead, farmstead planning and lay out; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control, systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures.

Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Greenhouses- types, poly houses /shed nets, cladding materials, plant environment interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system.

Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds.

Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family.

Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a green house; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Suggested Readings

1. Banerjee, G. C. 2007. *A Text Book of Animal Husbandry*. Oxford IBH Publishing Co, New Delhi.
2. Dutta, B. N. 2016. *Estimating and Costing in Civil Engineering*. Dutta & Co, Lucknow.
3. Garg, S. K. 2010. *Water Supply Engineering*. Khanna Publishers, New Delhi.
4. Khanna, P. N. 1958. *Indian Practical Civil Engineer's Hand Book*. Engineer's Publishers, New Delhi.
5. Nathonson, J. A. 1996. *Basic Environmental Technology*. Prentice Hall of India, New Delhi.
6. Ojha, T. P. and Michael, A. M. 1966. *Principles of Agricultural Engineering*. Vol. I. Jain Brothers, Karol Bag, New Delhi.
7. Pandey, P. H. 2004. *Principles and Practices of Agricultural Structures and Environmental Control*. Kalyani Publishers, Ludhiana.
8. Rao, P. V. 2012. *Text Book of Environmental Engineering*. Prentice Hall of India, New Delhi.
9. Sahay, K. M. and Singh, K. K. 2004. *Unit Operations of Agricultural Processing*. Vikas Publishing Pvt. Ltd, Noida.

Bioenergy Systems: Design and Applications 3 (2+1)

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems.

Biomass production- wastelands, classification and their use through energy plantation; Selection of species, methods of field preparation and transplanting; Harvesting of biomass and coppicing characteristics; Biomass preparation techniques for harnessing (size reduction, densification and drying).

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes.

Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Suggested Readings

1. Basu, P. 2018. *Biomass Gasification, Pyrolysis and Torrefaction*. Academic Press.
2. Butler, S. 2005. *Renewable Energy Academy: Training Wood Energy Professionals*.
3. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press.
4. Rai, G. D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
5. Reed, T. B. and Das, A. 1988. *Handbook of Biomass Downdraft Gasifier Engine Systems*. SERI.

Refrigeration and Air Conditioning 3 (2+1)

Objective

1. To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment

2. To enable them to design the refrigeration and air conditioning systems

Theory

Definition of pure substance, phases of a pure substance, phase change process of a pure substances; compressed liquid and saturated liquid, saturated vapour and superheated vapour, saturated temperature and saturated pressure; T-V diagram for heating of water at constant pressure.

Latent heat: Latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram; property tables, state-liquid and vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid.

Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T-S, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system.

Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric processes.

Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency; Study of heat pump test rig; Study of Ice plant test rig; Study of psychrometric chart and various psychrometric processes; Solving problems on psychrometrics; Study of window air conditioner; Study cold storage for fruit and vegetables, freezing load and time calculations for food materials; Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to chilling or ice making and cold storage plants.

Suggested Readings

1. Arora, C. P. 2012. *Refrigeration and Air Conditioning*. Tata-McGraw-Hill, New Delhi.
2. Khurmi, R. S. 2016. *Refrigeration and Air Conditioning*. S Chand and Co. Ltd, Ram Nagar, New Delhi.

Post-Harvest Engineering of Horticultural Crops 2 (1+1)

Objective

To make the students acquainted with unit operations in processing of major horticultural crops and working principles of different machineries for these.

Theory

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling).

Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction; Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment.

Drying: Dryers for fruits and vegetables, osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans; Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical and cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores.

Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers; Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practical

Preparation of different processed horticultural products; Study of fruit graders; Study of different types of peelers and slicers; Study of juicer and pulper; Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching; Study of different dryers for fruits and vegetables; Study of foam mat drying and osmotic dehydration processes; Study of different activities in pack house; Cold storage heat load calculations and design; Study of different types of packaging materials; Study of CAS and MAP of vegetables; Study of shrink packaging of foods; Study of hammer mill, pulveriser for grinding of spices to powder; Visit to fruit and vegetable processing/ spice processing plant.

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
2. Fellows, P. J. 2008. *Food Processing Technology Principles and Practices*. Woodhead Publishing.
3. Lal, G., Siddappa, G. S. and Tondon, G. L. 2009. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
4. Mangaraj, S., Ali, N., Swain, S. and Dash, S. K. 2016. Agricultural Process Engineering Vol. III.

Kalyani Publishers, New Delhi

5. Pandey, P. H. 1997. *Post-harvest Technology of Fruits and Vegetables (Principles and practices)*. Saroj Prakashan, Allahabad.
6. Srivastava, R. P. and Kumar, S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. Kalyani Publishers, New Delhi.
7. Sudheer, K. P. and Indira, V. 2007. *Post-Harvest Engineering of Horticultural Crops*. New India Publishing House.

Case study **1 (0+1)**

Objectiv

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

1. Study the status of farm mechanization and agro-processing in a particular village and to suggest improvement measures
2. Study a specific watershed and suggest measures for rejuvenating the watershed
3. Study the losses of fruits and vegetables in a local market yard and suggest remedial measures
4. Study the supply chain for a commodity and suggest a suitable value chain
5. Visit to a village to study the energy consumption pattern and suggest measures for efficient energy use and integration of renewable energy for different farm operations
6. Visit to an orchard and suggest measures for optimized water use
7. Visit to a retail store/ farm machinery dealer and report on supply chain network
8. Visit to a retail store and study the different types of packaging materials
9. Visit to an entrepreneur and study his journey to success (or reasons of failure)

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

The activity and presentations are recommended to be accommodated on Saturdays. A teacher will be designated as the facilitator for the programme.

Semester VII

Project-I 3 (0+3)

Objective

To strengthen the skill of the students and for developing their confidence to take up either research or employment/ entrepreneurship as a future career.

Activity

The activities should aim at development of advanced skill for research/ employment and entrepreneurship. The activities can be planned considering the total 7 credit hours allocated in the 7th and 8th semesters, viz. Project I (0+3 credit hours in 7th semester) and Project II (0+4 credit hours in the 8th semester).

The course can be taken either for developing research skills in form of project (R and D based, field study based) or for entrepreneurship development (incubation/ experiential learning based). The student will have the option to choose the mode of this course in consultation with a faculty mentor (each student will be attached to a mentor either from the College/ University or from any organisation/ industry).

Engineering Graphics and Design 2 (0+2)

Objective

1. To acquaint the students with CAD softwares for drawing of machine components
2. To integrate the computers at various levels of planning and manufacturing

Practical

Application of computers for design; CAD- introduction, overview of CAD window; Various options on drawing screen; Practice on draw and dimension tool bar; Practice on OSNAP, line thickness and format tool bar; Practice on mirror, offset; Practice on array commands; Practice on trim, extend; Practice on trim chamfer and fillet commands; Practice on copy, move, scale and rotate commands; Drawing of 2 D- drawing using draw tool bar; Practice on creating boundary, region, hatch and gradient commands; Practice on Editing polyline- PEDIT and Explode commands; Setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes; 2D- drawing of machine parts with all dimensions and allowances; Drawing of foot step bearing, knuckle joint; Sectioning of foot step bearing and stuffing box; Drawing of hexagonal, nut and bolt and other machine parts; Practice on 3-D commands- Extrusion and lift, sweep and press pull, revolving, joining; Demonstration on CNC machine and practice problems.

Suggested Readings

1. Lee, K. 1999. *Principles of CAD/CAM/CAE Systems*. Addison Wesley Longman, Inc.
2. Rao, P. N. 2002. *CAD/CAM Principles and Applications*. McGraw-Hill Education Pvt. Ltd., New Delhi.
3. Sareen, K. and Grewal, C. D. 2010. *CAD/CAM Theory and Practice*. S. Chand & Company Ltd., New Delhi.

4. Zeid, I. 2011. *Mastering CAD/CAM with Engineering*. McGraw-Hill Education Pvt. Ltd., New Delhi.

Food Quality and Safety 3 (2+1)

Objectives

To enable the student to know about the concept and aim of food quality and safety, food quality characteristics – physical, chemical and biological properties, different hazards and their prevention, different methods for measuring food quality as well as the food safety management system

Theory

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices.

Quality control, quality control tools, statistical quality control; Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials; Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.

Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy.

Sensory evaluation methods, panel selection methods, Interpretation of sensory results.

Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC; Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC); Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry.

Practical

Study of statistical process control in food processing industry; Study of sampling techniques, tools and protocols used in different types of from food handling, processing and marketing establishments; Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds and pulses from go-downs and market shops in relation to specifications provided by standardization techniques; Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI; Detection of adulteration and examination of spices for Agmark/ FSSAI standards; Detection of adulteration and examination of milk and milk products for FSSAI standards; Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification; Visit to a professional quality control laboratory; Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

Suggested Readings

1. Acharya, K. T. 2017. *Everyday Indian Processed foods*. National Book Trust.

2. Gupta, V. (Ed.). 2006. *The Food Safety and Standards Act along with Rules & Regulations*. Commercial Law Publishers (India) Pvt. Ltd.
3. Jha, S. N. 2015. *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*. Elsevier, USA (ISBN 9780124200845), p266.
4. Jha, S. N. (Ed.). 2010. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer – Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3-642-15796-7: 288p.
5. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. *Food Science*. New Age International Publishers.
6. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. *Hand book of Cereal Technology*. Kalyani Publishers, New Delhi.
7. Potter, N. N. and Hotchikss, J. H. 1995. *Food Science*. Chapman and Hall Pub.
8. Raj, D., Sharma, R. and Joshi, V. K. 2011. *Quality for Value Addition in Food Processing*. New India Publishing Agency, New Delhi
9. Ranganna, S. 1986. *Hand book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill Education.
10. Sharma, A. 2017. *A Textbook of Food Science and Technology*. CBS Publishers & Distributors.
11. Srivastava, R. P. and Kumar, S. 2017. *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Company.

Websites and weblinks:

12. https://www.fssai.gov.in/cms/food-safety-and-standards-regulations.php
13. https://www.fssai.gov.in/cms/food-recall.php
14. https://www.fao.org/fao-who-codexalimentarius/en/

Watershed Planning and Management 3 (2+1)

Objective

To acquaint the students with different aspects of watershed planning and management including participatory approaches and also on the integrated watershed management practices

Theory

Watershed- introduction and characteristics; Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index.

Community mobilization and participatory institution building: participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture.

Water budgeting in a watershed; Management measures - rainwater conservation technologies *in-situ* and *ex-situ* storage, water harvesting and recycling; Dry farming techniques - inter-terrace and inter-bund land management; Integrated watershed management- concept, components, arable

lands - agriculture and horticulture, non-arable lands- forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology.

Application of remote sensing and GIS in watershed planning and management; Introduction to Remote Sensing and GIS, Map projections and co-ordinate system. Spatial data structure: Raster, vector. Spatial relationship. Topology. Delineation of watersheds and generation of stream network; Preparation of various thematic maps in watershed; Hydrological Response Unit (HRU); Prioritization of watersheds; Watershed characterization; Watershed action plan; Analytical Hierarchy Process; Watershed evaluation and impact assessment; Quantification of surface and groundwater resources in watersheds; Computer models used for hydrologic and watershed modelling; Soil water assessment tool (SWAT); Case studies.

Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including cost-benefit analysis; Financial management and accounting procedure

Practical

Delineation of watersheds using toposheets; Surveying and preparation of watershed map; Quantitative analysis of watershed characteristics and parameters; Investigations on watershed for planning and development including PRA; Analysis of hydrologic data for planning watershed management; Measurement of discharge and sediment in a watershed; Water budgeting of watersheds; Study of thematic maps using remote sensing; Study of watershed action plan using GIS; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study on components of earth embankments and its design; Study of watershed management technologies; Study of role of various functionaries in watershed development programs; Study of accounting and financial management systems in watershed entities; Visit to watershed development project areas.

Suggested Readings

1. Das, G. 2008. *Hydrology and Soil Conservation Engineering: Including Watershed Management*. 2nd edn. Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal, J. C., Singh, R. P., Sharma, S., Das, S. K., Padmanabhan, M. V. and Mishra, P. K. 1995. *Field Manual on Watershed Management*. CRIDA, Hyderabad.
3. Mahnot, S. C. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service. New Delhi.
4. Rajora, R. 2019.*Integrated Watershed Management*. Rawat Publications, New Delhi.
5. Sharda, V. N., Sikka, A. K. and Juyal, G. P. 2006. *Participatory Integrated Watershed Management: A Field Manual*. Central Soil and Water Conservation Research and Training Institute, Dehradun.
6. Singh, G. D. and Poonia, T. C. 2003. *Fundamentals of Watershed Management Technology*. Yash Publishing House, Bikaner.
7. Thomas, C. G. 2010. *Land Husbandry and Watershed Management*. Kalyani Publishers, Ludhiana.

Sprinkler and Micro Irrigation Systems 2 (1+1)

Objective

To make the students acquainted with the importance of micro irrigation systems, their design and lay out for efficient water, fertilizer and pesticides applications.

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system; Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency.

Micro Irrigation systems: types- drip, spray, and bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler; Study of discharge and uniformity coefficient; Design and installation of sprinkler irrigation system; Study of cost economics of sprinkler irrigation system; Study on maintenance of sprinkler irrigation system; Field visit to a sprinkler irrigation project; Study of different components of drip irrigation; Design and installation of drip irrigation system; Determination of pressure discharge relationship and emission uniformity for given emitter; Study of different types of filters and determination of filtration efficiency; Study of fertigation, types of liquid fertilisers, determination of rate of injection and calibration for chemigation/ fertigation; Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters; Study on maintenance of drip irrigation system; Study of cost economics of drip irrigation system; Field visit to micro irrigation system and evaluation of drip system; Field visit to study foggers.

Suggested Readings

1. Jain, S. C. and Philip, G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors, Delhi.
2. Mane, M. S. and Ayare, B. L. 2007. *Principles of Sprinkler Irrigation system*. Jain Brothers, New Delhi.
3. Mane, M. S. and Ayare, B. L. and Magar, S. S. 2006. *Principles of Drip Irrigation systems*. Jain Brothers, New Delhi.
4. Michael, A. M., Shrimohan and Swaminathan, K. R. 1972. *Design and evaluation of irrigation methods (IARI Monograph No.1)*. Water Technology Center, IARI New Delhi.
5. Michael, A. M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing, New Delhi.

6. Sivanappan, R. K. 1992. *Sprinkler Irrigation*. Oxford & IBH Publishing House, New Delhi.
7. Suresh, R. 2010. *Micro Irrigation - Theory and Practices*. Standard Publishers Distributors, Delhi.

Machine Design 2 (2+0)

Objective

To make the students acquainted with design considerations for various machine components so as to enable them to take up the work of new design

Theory

Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings.

Suggested Readings

1. Bhandari, V. B. 2007. *Introduction to Machine Design*. Tata Mc. Graw Hill Publishing House. New Delhi.
2. Jain, R. K. 2013. *Machine Design*. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2014. *A Text Book of Machine Design*. S. Chand & Company Ltd., New Delhi.
4. Sharma, P. C. and Agarwal, D. K. 2010. *Machine Design*. S. K. Kataria & Sons, New Delhi.

Electrical Machines 3 (2+1)

Objective

1. To make the students acquainted with operating principles of various electrical motors and other machines
2. To help them gain practical exposure of different electrical devices and their controls

Theory

Introduction to electrical machines; Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit: concept of magnetic flux production, magneto motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses.

Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load/ load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; D.C. machines: principles operation and performance of DC

machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control.

Three phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition. phasor diagram, starting and speed control methods; Single phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics.

Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3-point Starter; To start and run the D.C. motor (shunt, series and compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; Toperformno-loadteston3-phase induction motor and to determine its no-load losses; To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters and to draw the circle diagram; To perform no load on1-phase induction motor to determine its no-load losses; To perform blocked-rotor test on 1-phase induction motor and to determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-teston1-phase induction motor and plot torque-speed characteristic.

Suggested Readings

1. Anwani, M. L. 1997. *Basic Electrical Engineering*. Dhanpat Rai & Co. (P) LTD. New Delhi.
2. Boylestad, Robert, L. and Louis, N. 2015. *Electronic Devices and Circuit*. 11th edn. Pearson India.
3. Shaney, A. K. 1997. *Measurement of Electrical and Electronic Instrumentation*. Khanna Publications
4. Thareja, B. L. and Theraja, A. K. 2005. *A Textbook of Electrical Technology.* Vol. I. S. Chand & Company LTD., New Delhi.
5. Theraja, B. L. and Theraja, A. K. 2005. *A Textbook of Electrical Technology.* Vol. II. S. Chand & Company LTD., New Delhi.

Agricultural Statistics and Data Analysis 2 (1+1)

Objective

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts.

Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation.

Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean.

Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table).

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table) and m × n.

Suggested Readings

1. Agrawal, B. L. 1991. *Basic Statistics.* Wiley Eastern Ltd. New Age International Ltd.
2. Chandel, S. R. S. 1999. *A Handbook of Agricultural Statistics*. Achal Prakasan Mandir, Kanpur
3. Gupta, S. C. and Kapoor, V. K. 1970. *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.
4. Gupta, S. C. and Kapoor, V. K. 2019. *Fundamental Applied Statistics*. Sultan Chand & Sons.
5. Nageswara Rao, G. 2007. *Statistics for Agricultural Sciences*. BS Publications.
6. Rangaswamy, R. 2018. *A Text Book of Agricultural Statistics*. New Age Int. publications Ltd.

Semester VIII

S. No.	Course Title	Credit hours
1.	Project -II	4 (0+4)
2.	In-plant Training/ Research Internship	8 (0+8)
3.	Elective- I	3 (2+1)
4.	Elective- II	3 (2+1)
5.	Elective- III	3 (2+1)
	Total	**21 (6+15)**

Project-II 4 (0+4)

This will be the continuation of work/ study taken under the course Project- I

In-plant Training/ Research Internship (8 weeks) 8 (0+8)

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute. In addition, students will have an opportunity to enhance those skills, obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice.

Activity

The students will have internship/ training for 8 weeks' duration in industries/ research organisations/ institutions. The College/ University will facilitate attaching the students to the organisations. In-plant training may be conducted in split manner in more than one industry/ organization/ institute.

After completion of training/ internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

Note: Considering that the students will be out of the campus for 8 weeks within the semester, the timetable for the remaining part of the semester should be so adjusted that each credit hour will have minimum of 15 classes.

Electives- I 3 (2+1)

The options for Elective courses and the details are given after this section.

Elective- II 3 (2+1)

The options for Elective courses and the details are given after this section.

Elective- III 3 (2+1)

The options for Elective courses and the details are given after this section.

ELECTIVE COURSES

The detailed syllabi of elective courses is given below.

Mechanics of Tillage and Traction 3 (2+1)

Objective

To enable the students to

1. Know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools
2. Know the application of dimensional analysis on soil dynamics and traction
3. Understand the effect of soil compaction on crop growth
4. Know the use of GIS in soil dynamics

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship; Design of tillage tools, principles of soil cutting, design equation, force analysis; Application of dimensional analysis in soil dynamics and traction prediction equation.

Introduction to traction and mechanics, off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; Application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage; Soil parameters related to puddling and floatation; Draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Suggested Readings

1. Gill and Vandenberg. 1968. *Soil Dynamics in Tillage and Traction*. Agricultural Research Service, USDA, Govt. Printing Press, Washington, D.C.
2. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. *Tractors and their Power Units*. CBS Publishers
3. Macmillan R H. 2002. *The Mechanics of Tractor-Implement Performance*. International Development Technologies Centre, University of Melbourne.
4. Terzaghi K and Peck R B and Mesri G. 1996. *Soil Mechanics in Engineering Practices*. John Willey & Sons.

Farm Machinery Design and Production 3 (2+1)

Objective

To enable the students to design farm machinery and to understand the production principles

Theory

Introduction to design parameters of agricultural machines and design procedure, characteristics of farm machinery design, research and development aspects of farm machinery; Introduction to safety in power transmission; Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery; Cutting tools including CNC tools and finishing tools; Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and fixtures; Industrial lay-out planning, quality production management, reliability; Economics of process selection, familiarization with project report.

Practical

Familiarization with different design aspects of farm machinery and selected components; Solving design problems on farm machines and equipment; Visit to agricultural machinery manufacturing industry, tractor manufacturing industry; Study of jigs and fixtures in relation to agricultural machinery; Study of fits, tolerances and limits; Layout planning of a small scale industry; Problems on economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Suggested Readings

1. Adinath, M. and Gupta, A. B. 1996. *Manufacturing Technology*. New Age International (P) Ltd.
2. Narula, V. 2009. *Manufacturing Processes*. S K Kataria & Sons, New Delhi.
3. Richey, C. B. 1961. *Agricultural Engineering Handbook*. McGraw-Hill Inc., US.
4. Sharma, D. N. and Mukesh, S. 2021. *Farm Machinery Design (Principles and Problems)*. 4th Revised Edition. Jain Brothers, New Delhi.
5. Sharma, P. C. and Aggarwal, D. K. 2010. *Machine Design*. S K Kataria & Sons, New Delhi.
6. Singh, S. 2016. *Mechanical Engineer's Handbook*. Khanna Publications, New Delhi.

Tractor Design and Testing 3 (2+1)

Objective

To enable the students to understand

1. Parameters for balanced design of tractor for stability and weight distribution
2. Special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.
3. Perform testing of tractor

Theory

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability and weight distribution; Traction theory; hydraulic lift and hitch system design; Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches; Rolling friction and anti-friction bearings; Design of Ackerman Steering and

tractor hydraulic steering; Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.; Design of seat and controls of an agricultural tractor; Tractor Testing.

Practical

Design problem of tractor clutch (single/multiple disc clutch); Design of gear box (synchromesh/ constant mesh), variable speed constant mesh drive; Selection of tractor tires; Problem on design of governor; Design and selection of hydraulic pump; Engine testing as per BIS code; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test; Hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Suggested Readings

1. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. Tractors and their Power Units. CBS Publishers and Distributors Pvt. Ltd.
2. Maleev, V. L. 1964. *Internal Combustion Engines*. McGraw-Hill Inc., US.
3. Mehta, M. L., Verma, S. R., Mishra, S. K. and Sharma, V. K. 1995. *Testing and Evaluation of Agricultural Machinery*. National Agricultural Technology Information Centre. Ludhiana.
4. Richey, C. B. 1961. *Agricultural Engineering Handbook*. McGraw-Hill Inc., US.
5. Singh, K. 2018. *Automobile Engineering* – Vol I and Vol II. Standard Publishers and Distributors. New Delhi.

Hydraulic Drives and Controls 3 (2+1)

Objective

To enable the students to understand the basic principles of hydraulic power system and tractor hydraulic system and different control measures

Theory

Basics of hydraulics: Pascal's law, flow, energy, work, and power; Hydraulic systems, colour coding, reservoirs, strainers and filters, filtering material and elements, accumulators, pressure gauges and volume meters; Hydraulic circuit, fittings and connectors; Pumps and its classifications, operation, performance, displacement; Design of gear pumps, vane pumps, piston pumps. hydraulic actuators; Cylinders, construction and applications, maintenance; Hydraulic motors, valves, pressure-control valves, directional- control valves, flow-control valves, valve installation, valve failures and remedies, valve assembly, troubleshooting of valves; Hydraulic circuit diagrams; USA Standards Institute (USASI) symbols; Tractor hydraulics, nudging system, ADDC, application of hydraulics and pneumatics drives in agricultural systems.

Practical

Introduction to hydraulic systems; Study of hydraulic pumps, hydraulic actuators; Study of hydraulic motors, hydraulic valves, colour codes and circuits; Building simple hydraulic circuits, hydraulics in tractors; Introduction to pneumatics, pneumatics devices, pneumatics in agriculture

Suggested Readings

1. Anthony, E. 2014. *Fluid Power and Applications*. Pearson Education Limited. USA.
2. Kepner, R. A., Roy, B. and E. L. B. 2000. *Principles of Farm Machinery*. CBC Publishers & Distributors, New Delhi.
3. Kuhar, J. E. (Ed.). 1992. *Hydraulics (Fundamentals of Service Series)*. John Deere and Co.
4. Majumdar, S. 2002. *Oil Hydraulic System: Principles and Maintenance*. McGraw-Hill
5. Meritt, H. E. 1991. *Hydraulic Control Systems*. John Wiley & Sons.

Human Engineering and Safety 3 (2+1)

Objective

To enable the students to understand the importance of human factors/ human engineering in farm machine design as well as for Implementation of ODMR and other safety aspects in farm operation

Theory

Human factors in system development- concept of systems, basic processes in system development, performance reliability, human performance; Information input process, visual displays, major types and use of displays, auditory displays; Speech communications; Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems; Human motor activities, controls, tools and related devices; Anthropometry: arrangement and utilization of work space, atmospheric conditions, thermo-regulation in human, thermal comfort, environmental factors, air pollution; Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor and trailer operation, etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter; Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view; Use of heart rate monitor; Study of general fatigue of the subject. using Blink ratio method, anthropometric measurements of a selected subject; Optimum work space layout and locations of controls for different tractors; Familiarization with the noise and vibration equipment; Familiarization with safety gadgets for various farm machines; Studies on drudgery of farm women in manual drawn equipment.

Suggested Readings

1. Astrand, P. and Rodahl, K. 1977. *Textbook of Work Physiology*. Mc Hill Corporation, New York.
2. Chapanis, A. 1996. *Human Factors in System Engineering*. John Wiley & Sons, New York.
3. Dul, J. and Weerdmeester, B. 1993. *Ergonomics for Beginners. A Quick Reference Guide*. Taylor and Francis, London.
4. Keegan, J. J. and Radke, A. O. 1964. *Designing Vehicle Seats for Greater Comfort*. SAE Journal, 72:50~5.
5. Mark, S. S. and McCormick, E. J. 1993. *Human Factors in Engineering and Design*. Mc Hill Corporation, New York.

6. Mathews, J. and Knight, A. A. 1971. *Ergonomics in Agricultural Equipment Design*. National Institute of Agricultural Engineering.
7. Yadav, R. and Tewari, V. K. 1998. *Tractor Operator Workplace Design-A Review*. Journal of Terra mechanics, 35: 41-53.

Precision Agriculture and System Management 3 (2+1)

Objective

1. To enable the students to understand the principles of precision agriculture and system management and the use of different equipment in precision agriculture
2. To learn the GIS based precision agriculture, sensors and application of sensors for data generation

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc.; Introduction to GIS based precision agriculture and its applications; Introduction to sensors and application of sensors for data generation; Database management; System concept, system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations; Application of PERT and CPM in machinery system management.

Practical

Familiarization with precision agriculture problems and issues; Familiarization with various machines for resource conservation; Solving problems related to various capacities, pattern efficiency, system limitation, etc; Problems related to cost analysis, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc.

Suggested Readings

1. DeMers M N. 2008. *Fundamentals of Geographic Information Systems*. Wiley.
2. Dutta, S. K. 1987. *Soil Conservation and Land Management*. International Book Distributors. Dehradun.
3. Hunt, D. 1956. *Farm Power and Machinery Management*. Iowa State College Press.
4. Kuhar, J. E. 1977. *The Precision Farming Guide for Agriculturist*. Lori J. Dhabalt, USA.
5. Sharma, D. N., Jain, M. and Lohan, S. K. 2021. *Farm Power and Machinery Management*. Jain Brothers.
6. Sigma and Jagmohan. 1976. *Earth Moving Machinery*. Oxford & IBH
7. Wood, S. 1977. *Heavy Construction: Equipment and Methods*. Prentice Hall

Photovoltaic Technology and Systems 3(2+1)

Objective

1. To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems
2. To know the installation of PV system both off grid and on grid

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation.

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter.

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Suggested Readings

1. Derrick, A., Francis, C. and Bokalders, V. 1991. *Solar Photo-voltaic Products*. Intermediate Technology Publications.
2. Meinel, A. B. and Meinel, M. P. 1976. *Applied Solar Energy: An Introduction*. Addison-Wesley Educational Publishers Inc.
3. Rai, G. D. 1998. *Non-conventional Sources of Energy*. Khanna Pub.
4. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications.
5. Solanki, C. S. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications.* PHI Learning Private Ltd.

Wind Power Technology and Systems 3 (2+1)

Objective

To enable the students to calculate and analyse wind resource and energy production from a wind turbine, Understand the typical control methods for wind turbines and the modes of wind power generation

Theory

Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation; Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator; Types of wind energy systems, wind to electrical energy conversion

alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system.

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system; Control and monitoring system of a wind farm, wind farm sitting; Wind map of India, wind-electric energy stations in India.

Practical

Detailed design and drawing of wind turbine; Study of horizontal axis wind turbine; Study of vertical axis wind turbine; Study of variation of wind speed with elevation; Study of validation of Weibull probability density function; Study of wind power density duration curve; Electrical characteristics and commissioning of complete aero-generator wind power system; Visit to a wind farm.

Suggested Readings

1. Kothari, D. P., Singal, K. C. and Ranjan, R. 2012. *Renewable energy sources and emerging technologies*. PHI Learning Private Limited. New Delhi.
2. Powar, A. G. and Mohod, A. G. 2010. *Fundamentals of wind energy utilization*. Jain Brothers Publisher, Karol Bagh, New Delhi.
3. Rai, G. D. 1998. *Non-conventional Sources of Energy*. Khanna Publisher, New Delhi.
4. Rao, S. and Parulekar, B. B. 2007. *Energy Technology*. Khanna Publishers, New Delhi.
5. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications, Udaipur.
6. Solanki, C. S. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications*. PHI Learning Private Ltd, New Delhi.
7. Tiwari, G. N. and Ghosal, M. K. 2005. *Renewable Energy Resources: Basic Principles and Applications*. Narosa Publishing House, New Delhi.

Waste and By-Products Utilization 3 (2+1)

Objective

1. To enable the students to understand the nature of agricultural wastes and the physical, chemical and biological basis of agricultural waste treatment
2. To analyse and design systems for the collection, handling, treatment and utilization of wastes

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting.

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste.

Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by-products.

Suggested Readings

1. Bhatia, S. C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.
2. Garg, S. K. 1998. *Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering*. Khanna Publishers, New Delhi
3. Joshi, V. K. and Sharma, S. K. 2011. *Food Processing Waste Management: Treatment & Utilization Technology*. New India Publishing Agency.
4. Markel, I. A. 1981. *Managing Livestock Waste.* AVI Publishing Co.
5. Pantastico, E. C. B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables.* AVI Pub. Co.
6. Prashar, A. and Bansal, P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
7. Shewfelt, R. L. and Prussi, S. E. 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc.
8. USDA. 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
9. Vasso, O. and Winfried, R. (Eds) 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science & Business Media, LLC 233 New York.
10. Weichmann, J. 1987. *Post-Harvest Physiology of Vegetables*. Marcel and Dekker Verlag.

Floods and Control Measures 3 (2+1)

Objective

To enable the students to Understand the flood forecasting and warning systems, different permanent and temporary control measures of flood, and to design of storage structures and dams

Theory

Floods- causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood, flood estimation- methods of estimation; Estimation of flood peak- rational method, empirical methods, unit hydrograph method; Statistics in hydrology, flood frequency methods- log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis, flood forecasting; Flood routing- channel routing, Muskingum method, reservoir routing, modified Pul's method; Flood control- history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.

Gully erosion and its control structures- design and implementation; Earthen embankments- functions, classification, hydraulic fill and rolled fill dams, homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes.

Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding, etc., stability of slopes- analysis of failure by different methods; Planning of flood control projects and their economics.

Practical

Determination of flood stage-discharge relationship in a watershed; Determination of flood peak-area relationships; Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of probable maximum flood, standard project flood and spillway design flood; Design of levees for flood control; Designing, planning and cost- benefit analysis of a flood control project; Design of earthen dams; Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition; Stability of slopes of earth dams by friction circle and other methods; Construction of flow net for isotropic and anisotropic media; Computation of seepage by different methods; Determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; Study of reservoir rule curve; Visit to earthen dam and flood control reservoir.

Suggested Readings

1. Arora, K. R. 2014. *Soil Mechanics and Foundation Engineering (Geotechnical Engineering)*. Standard Publishers Distributors, Delhi.
2. Bureau of Reclamation. 1987. *Design of Small Dams*. US Department of Interior, Washington DC, USA.
3. Garg, S. K. 2014. *Soil Mechanics and Foundation Engineering*. Khanna Publishers, Delhi.

4. Garg, S. K. 2018. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, Delhi
5. Michael, A, M. and Ojha, T. P. 2003. *Principles of Agricultural Engineering*. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Modi, P. N. 2010. *Irrigation and Water Power Engineering*. Standard Publishers Distributors, Delhi.
7. Murthy, V. V. N. 2010. *Land and Water Management Engineering*. 4th Edition, Kalyani Publishers, New Delhi.
8. Mutreja, K. N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., New York, Delhi.
9. Stephens, Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.
10. Subramanya, K. 2008. Engineering Hydrology. 3rd edn, Tata McGraw-Hill Publishing Co., New Delhi.
11. Suresh, R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.

Remote Sensing and GIS Applications 3 (2+1)

Objective

To enable the students to know about the remote sensing methods and applications in NRM, digital image processing and concepts of GIS and data management

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures, different types of sensors and platforms, contrast ratio and possible causes of low contrast, aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs; Air-photo interpretation- interpretation elements; Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing, GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; Use of software for image interpretation; Interpretation of aerial photographs and satellite imagery; Basic GIS operations such as image display;

Study of various features of GIS software package; Scanning, digitization of maps and data editing; Data base query and map algebra; GIS supported case studies in water resources management.

Suggested Readings

1. Elangovan, K. 2006. GIS *Fundamentals Applications and Implementations*. New India Publication Agency, New Delhi.
2. George, J. 2005. *Fundamentals of Remote Sensing*. 2nd Edn. Universities Press (India) Private Limited, Hyderabad.
3. Jensen, J. R. 2013. *Remote Sensing of the Environment: An Earth Resource Perspective*. Pearson Education Limited, UK.
4. Lillesand, T., Kiefer, R. W. and Chipman, J. 2015. *Remote Sensing and Image Interpretation*. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
5. Reddy, A. M. 2006. *Textbook of Remote Sensing and Geographical Information Systems*. BS Publications, Hyderabad.
6. Sabins, F. F. 2007. *Remote Sensing: Principles and Interpretation*. Third Edition, Waveland Press Inc., Illinois, USA.
7. Sahu, K. C. 2008. *Text Book of Remote Sensing and Geographic Information Systems*. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz, G. A. and Engman, E. T. 2000. *Remote Sensing in Hydrology and Water Management*. Springer, New York.

Information Technology for Land and Water Management 3 (2+1)

Objective

To enable the students to understand the application of IT natural resources management and design and application of decision support system and expert systems for NRM

Theory

Concept of Information Technology (IT) and its application potential, role of IT in natural resources management; Existing system of information generation and organizations involved in the field of land and water management; Application and production of multimedia, internet application tools and web technology, networking system of information, problems and prospects of new information and communication technology; Development of database concept for effective natural resources management; Application of remote sensing, geographic information system (GIS) and GPS; Rational data base management system, object oriented approaches; Information system, decision support systems and expert systems; Agricultural information management systems- use of mathematical models and programs; Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management; Video-conferencing of scientific information.

Practical

Multimedia production; Internet applications: E-mail, voice mail, web tools and technologies; Handling and maintenance of new information technologies and exploiting their potentials; Exercises

on database management using database and spreadsheet programs; Usage of remote sensing, GIS and GPS survey in information generation and processing; Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc.; Exercises on simple decision support and expert systems for management of natural resources; Multimedia production using different softwares; Exercises on development of information system on selected theme(s); Video-conferencing of scientific information.

Suggested Readings

1. Bian F and Xie Y (Eds.). 2015. *Geo-Informatics in Resource Management and Sustainable Ecosystem*. Springer, New York.
2. De, D. and Basavaprabhu, J. (Eds). 2010. *Communication Support for Sustainable Development*. Ganga Kaveri Publishing House, Varanasi.
3. FAO. 2013. *Climate-Smart Agriculture- Source Book*. FAO, Rome.
4. FAO. 1998. *Land and Water Resources Information Systems*. FAO Land and Water Bulletin 7, Rome.
5. ICFAI Business School (IBS). 2012. *Information Technology and Systems*. IBS Centre for Management Research, Hyderabad.
6. Loucks, D. P. and Beek, E. V. 2005. *Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications*. UNESCO, Paris.
7. Malliva, R. and Thomas, M. 2012. *Arid Lands Water Evaluation and Management*. Environmental Science. Springer, New York.
8. Sarvanan, R. 2011. *Information and Communication Technology for Agriculture and Rural Development*. New India Publishing Agency, New Delhi.
9. Soam, S. K., Sreekanth, P. D. and Rao, N. H. (Eds). 2013. *Geospatial Technologies for Natural Resources Management*. New India Publishing Agency, Delhi.

Wasteland Development 3 (2+1)

Objective

1. To enable the students to plan for wasteland development keeping in view of agro-climatic conditions, development options, contingency plans, conservation measures, water harvesting and recycling methods in consideration
2. To know the different land reclamation and rehabilitation measures for wasteland development and use of micro-irrigation for sustainable wasteland development against adverse situations like drought and water-scarce situations

Theory

Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions, Troll's climatic classification, denuded range land and marginal lands; Wastelands- factors causing waste lands, classification and mapping of wastelands, planning of wasteland development- constraints, agro-climatic conditions, development options, contingency plans; Conservation structures- gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods; Afforestation- agro-horti-forestry-silvipasture methods, forage and fuel crops, socioeconomic

constraints; Shifting cultivation, optimal land use options; Wasteland development- hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands; Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management; Micro-irrigation in wastelands development; Sustainable wasteland development- drought situations, socio-economic perspectives; Participatory approach in wasteland management; Preparation of proposal for wasteland development and benefit-cost analysis.

Practical

Mapping and classification of wastelands; Identification of factors causing wastelands; Estimation of vegetation density and classification; Planning and design of engineering measures for reclamation of wastelands; Design and estimation of different soil and water conservation structures under arid, semi-arid and humid conditions; Planning and design of micro-irrigation in wasteland development; Study on utilization of fly-ash in hydraulic structures; Study on mine spoil areas by plantation; Study on mine spoil areas by back filling of fly-ash; Study on environmental impact assessment (EIA) of mine spoil areas; Cost estimation of the various wasteland development measures; Study on PRA exercise on wasteland management; Preparation of DPR of wasteland development projects; Visit to wasteland development project sites.

Suggested Readings

1. Abrol, I. P. and Dhruvanarayana, V. V. 1998. *Technologies for Wasteland Development*. ICAR, New Delhi.
2. Ambast, S. K., Gupta, S. K. and Singh, G. (Eds). 2007. *Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands*. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Karthikeyan, C., Thangaraja, K., Fernandez, C. C. and Chandrakandon, K. 2009. *Dryland Agriculture and Wasteland Management*. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
4. Lal, R. and Stewart, B. A. (Eds). 2015. *Soil Management of Smallholder Agriculture*. Volume 21 of Advances in Soil Science. CRC Press, USA.
5. Malliva, R. and Missimer, T. 2012. *Arid Lands Water Evaluation and Management*. Springer Heidelberg, New York.
6. Pachauri, R. K. and Sridharan, P. V. (Eds) 2003. *Looking Back to Think Ahead Green India 2047*. TERI, New Delhi.
7. Swaminathan, M. S. 2010. *Science and Integrated Rural Development*. Concept Publishing Company (P) Ltd., Delhi.
8. Virmani, S. M (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.
9. Yadav, H. R. 2013. *Management of Wastelands*. Concept Publishing Company. New Delhi.

Minor Irrigation and Command Area Development 3 (2+1)

Objective

To enable the students to importance of command area development programs in irrigation projects and to plan, design, execute and evaluate on-farm development works

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation projects; Types of minor irrigation systems in India, surface water and groundwater projects; Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank irrigation: grouping of tanks, storage capacity, supply works and sluices; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams.

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association; Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity.

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house; Planning and design of OFD works; Cost estimation of OFD work; Study of cross-drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

Suggested Readings

1. Arora, K. R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg, S. K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, New Delhi.
3. Michael, A. M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House New Delhi.
4. Reddi, G. H. S. and Reddy, T. Y. 2005. *Efficient use of Irrigation Water*. Kalyani Publishers, Ludhiana.
5. Sahasrabudhe, S. R. 2011. *Irrigation Engineering and Hydraulic structures*. SK Kataria & Sons, Reprint 2015.

Management of Canal Irrigation System 3 (2+1)

Objective

To enable the students to analyse water requirement and availability in a canal command, to take up design of lined and unlined canals and enable to control of losses of water in canal commands and for design and layout of different canal outlet structures

Theory

Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation; Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty; Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory; Maintenance of unlined irrigation canals, measurement of discharge in canals; Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi; Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials, design of lined canals; Functions of distributary head and cross regulators; Canal falls, their necessity and factors affecting canal fall, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties.

Practical

Estimation of water requirement of canal commands; Determination of canal capacity; Layout of canal alignments on topographic maps; Drawing of canal sections in cutting; Design of canal by full banking and partial cutting; Determination of longitudinal section (L-section) of canals; Design of irrigation canals based on silt theories (unlined canal); Design of lined canals; Formulation of warabandi system in canal command areas; Study of various types of canal outlet; Study of various types of canal regulators; Study of canal escapes; Study of various types of canal falls; Visit to a canal off taking site; Visit to a canal command area; Visit and discussion with functionaries of water user association.

Suggested Readings

1. Arora, K. R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg, S. K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers New Delhi.
3. Sahasrabudhe, S. R. 2011. *Irrigation Engineering and Hydraulic Structures*. S K Kataria & Sons. Reprint 2015.

Water Quality and Management Measures 3 (2+1)

Objective

To enable the students to understand the quality of surface and ground water, water contamination due to inorganic and organic compounds and the water decontamination technologies and the cultural and management practices for using poor quality water for irrigation

Theory

Natural factors affecting quality of surface water and groundwater, sources and pollution of groundwater; Water quality objectives in relation to domestic, industrial and agricultural activities,

drinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria; Point and non-point water pollution sources; Water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds; Arsenic and fluoride contamination in groundwater and remedial measures; Water decontamination technologies; Cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; Soil chemical analysis and estimation of lime and gypsum requirements; Study of salinity development under shallow and deep water table conditions; Study of saline water ingress in coastal areas; Study of contamination movement and transport in soil profile; Study of turbidity of water through turbidity meter; Study of different water decontamination techniques; Study of different cultural and management practices for using poor quality water for irrigation; Visit to a water treatment plant; Visit to a water quality laboratory; Field visit to industrial effluent disposal sites.

Suggested Readings

1. FAO. 1996. *Control of Water Pollution from Agriculture - FAO Irrigation and Drainage*. Paper 55.
2. Gray, N. F. 2010. *Water Technology*. CRC Press.
3. Hussain, S. K. 1986. *Text Book of Water Supply and Sanitary Engineering*. Oxford & IBH Publishing Co. New Delhi.
4. Manahan, S. E. 2009. *Fundamentals of Environmental Chemistry*. CRC Press, New York.
5. McGauhey, P. H. 1968. *Engineering Management of Water Quality*. McGraw Hill Book Company, New York.
6. Minhas, P. S. and Tyagi, N. K. 1998. *Guidelines for Irrigation with Saline and Alkali Waters*. Bull. No, 1/98, CSSRI, Karnal, p. :36
7. Punmia, B. C. and Lal, P. B. B. 1981. *Irrigation and Water Power Engineering*. Standard Publishers Distributors, Delhi.

Landscape Irrigation Design and Management 3 (2+1)

Objective

To enable the students to know about the different conventional and modern methods of landscape irrigation, various types of landscapes and their suitability with regard to different irrigation methods, design the modern landscape irrigation systems, automation of the landscape irrigation system and irrigation scheduling with proper methods of irrigation for different landscapes

Theory

Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems; Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes; Segments of landscape irrigation systems, main components

of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application; Use of sensors for irrigation automation and use of IOT in landscape irrigation.

Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

Study of irrigation equipment for landscapes; Design and installation of irrigation system for landscape; Determination of water requirement; Determination of power requirement, pump selection; Irrigation scheduling of landscapes; Study of irrigation controllers and other equipment; Use of AutoCAD in irrigation design; Study of blocks and symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.; Study of various types of sensors for irrigation automation; Study of IoT in landscaping irrigation; Visit to landscape irrigation system and its evaluation.

Suggested Readings

1. Michael, A. M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
2. Singh, N. P. 2010. *Landscape Irrigation and Floriculture Terminology*. Bangalore.
3. Smith, S. W. 1996. *Landscape Irrigation: Design and Management*. John Wiley and Sons, Inc., New York, United States.

Application of Plastics in Agriculture 3 (2+1)

Objective

To enable the students to understand the applications in moisture conservation, canal and pond lining, use of plastic pipes in irrigation and drainage; know about soil solarisation, mulching, covering materials in green houses, shade houses, poly houses, surface covered cultivation, plastic fencing, nets for insects, birds etc. and in food grain structures, packaging materials, aquaculture, etc.

Theory

Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures; Water management- use of plastics in in-situ moisture conservation and rain water harvesting; Plastic film lining in canal, pond and reservoir, plastic pipes for irrigation water management, bore-well casing and subsurface drainage, drip and sprinkler irrigation systems, use of polymers in control of percolation losses in fields; Soil conditioning- soil solarisation, effects of different colour plastic mulching in surface covered cultivation; Nursery management- use of plastics in nursery raising, nursery bags, trays, etc.; Controlled environmental cultivation- plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers; Plastic nets for crop protection- anti insect nets, bird protection nets, plastic fencing.

Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products, Plastic CAP covers for storage of food grains

in open; Use of plastics as alternate material for manufacturing farm equipment and machinery; Plastics for aquacultural engineering and animal husbandry- animal shelters, vermi-beds and inland fisheries; Silage film technique for fodder preservation; Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications.

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds; Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals; Study of components of subsurface drainage system; Study of different colour plastic mulch laying; Design, estimation and installation of green, poly and shade net houses, low tunnels, etc; Study on CAP device for food grain storage; Study of innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP; Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters; Preparation of vermi-bed and silage film for fodder preservation; Study of plastic parts in making farm machinery; Visits to nearby manufacturing units/ dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ poly-house/ shade-house/ net-house etc; Visits to farmers' fields with these installations.

Suggested Readings

1. Brown, R. P. 2004. *Polymers in Agriculture and Horticulture*. RAPRA Review Reports: Vol. 15, No. 2, RAPRA Technology Limited, U.K.
2. Central Pollution Control Board. 2012. *Material on Plastic Waste Management*. Parivesh Bhawan, East Arjun Nagar, Delhi.
3. Charles A. Harper. 2006. *Handbook of Plastics Technologies*. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
4. Chanda, M. and Roy, S. K. 2008. *Plastics Fundamentals, Properties, and Testing*. CRC Press.
5. Dubois. 1978. *Plastics in Agriculture*. Applied Science Publishers Limited, Essex, England.
6. Ojha, T. P. and Michael, A. M. 2012. *Principles of Agricultural Engineering - I*. Jain Brothers, Karol Bagh, New Delhi.
7. Pandey, P. H. 2014. *Principles and Practices of Agricultural Structures and Environmental Control*. Kalyani Publishers, Ludhiana, India.
8. Shankar, A. N. 2014. *Integrated Horticulture Development in Eastern Himalayas*. Plasticulture in Agri-Horticulture Systems, 241-247.
9. Singh, Brahma, Singh, B., Sabir, N. and Hasan, M. 2014. *Advances in Protected Cultivation*. New India Publishing Agency, New Delhi.
10. Srivastava, R. K., Maheswari, R. C., Ojha, T. P. and Alam, A. 1988. *Plastics in Agriculture*. Jain Brothers, Karol Bagh, New Delhi.

Precision Farming Techniques for Protected Cultivation 3 (2+1)

Objective

1. To enable the students to design and construction of green houses in different agro-climatic zones, greenhouse cooling and heating systems, environmental parameter and control, ventilation systems

2. To assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation and to know about hydroponics, post-harvest management, pest management and economic aspects of a green house

Theory

Protected cultivation: introduction, history, origin, development, national and international scenario.

Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment; Design and construction of greenhouses- site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation.

Planting techniques in green house cultivation; Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement; Maintenance of irrigation and fogging systems.

Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application.

Greenhouse climate measurement, control and management; Insect and disease management in greenhouse and net houses; Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis.

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; Design and installation of irrigation system; Design and installation of fogging system; Study of different greenhouse environment control instruments; Study of operation, maintenance and fault detection in irrigation system; Study of operation, maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Suggested Readings

1. Sharma, P. 2007. *Precision Farming*. Daya Publishing House New Delhi.
2. Singh, B. and Singh, B. 2014. *Advances in Protected Cultivation*. New India Publishing Company.

Environmental Engineering 3 (2+1)

Objective

To enable the students to understand-

1. The water requirements for domestic, industrial and commercial demand and sources of water supply, analysis of water quality. importance to sanitation, domestic waste water treatment, sewer design, disposal of waste water in urban and rural areas
2. The air pollution, types of pollutants, and their abetments

Theory

Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand- variation in demand, population estimation- design period, population forecasting methods; Sources of water supply- surface and sub-surface sources of water, surface sources-lakes, rivers, reservoirs; Intakes and transportation of water- various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits- design of pressure pipes as gravity mains, Darcy-Wesbach, Manning, Hazen-William formula, flow in pipes system- forces acting on pressure conduits-cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and testing of pipes, testing of pipes; Selection of pumps, efficiency of pumps, economic diameter of pumping mains; Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods.

Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas; Sewer: types, design discharge and hydraulic design, Introduction to domestic wastewater treatment. Design of septic tank, sewerage system- domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen; Solid water collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas.

Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments.

Practical

Study of population forecasting problems; Determination of turbidity, pH and EC of water; Study of suspended solids, dissolved solids and total solids; Study of temporary and permanent hardness; Determination of fluorides and chlorides in drinking water; Determination of dissolved oxygen, COD and BOD of water; Study of hydraulics of pipe lines and distribution network design; Visit to a water treatment plant; Study of maintenance of distribution system; Collection of air samples and their analysis; Design of septic tank, sewer pipe lines and waste disposal measures; Visit to a sewage treatment plant; Visit to a municipal solid waste management plant; Visit to a community bio gas plant.

Suggested Readings

1. Chatterjee, A. K. 2006. *Water Supply, Waste Disposal & Environmental Engineering*. Khanna Publishers, Delhi

2. Garg, S. K. 1977. *Environmental Engineering.* Vol, I and II. Khanna Publishers, Delhi
3. Rao, P. V. 2002. *Text book of Environmental Engineering*. Prentice Hall of India Pvt. Ltd.

Development of Processed Food Products 3 (2+1)

Objective

To enable the students to know about the

1. Unit operations and equipment used for different food processing operations
2. Processing technologies for value addition of cereals, pulses, oilseeds, vegetables, fruits, milk, fish, meat and poultry products

Theory

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind; Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Practical

Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/ vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Suggested Readings

1. Acharya, K. T. 2017. *Everyday Indian Processed Foods*. National Book Trust.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
3. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. *Food Science*. New Age International Publishers.
4. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. *Handbook of Cereal Technology*. Kalyani Pub.
5. Potter, N. N. and Hotchkiss, J. H. 1995. *Food Science*. Chapman and Hall Pub.
6. Rao, D. G. 2009. *Fundamentals of Food Engineering*. PHI Learning Pvt. Ltd, New Delhi.
7. Srivastava, R. P. and Kumar, S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Company.

Food Packaging Technology 3 (2+1)

Objective

To enable the students to

1. Understand the interaction of food, packaging and environment
2. Understand the different methods of package development and packaging
3. Select the best type and form of packaging of specific food for specific end users

Theory

Factors affecting shelf life of food material during storage, interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy.

Packaging of foods, requirement, importance and scope, environmental considerations; Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; Different types of packaging materials, their key properties and applications; Metal cans- manufacture of two piece and three piece cans; Plastic packaging- different types of polymers and lamination used in food packaging and their barrier properties; Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding; Glass containers- types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers; Paper and paper board packaging- paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards; Relative advantages and disadvantages of different packaging materials, effect of these materials on packed commodities.

Nutritional labelling on packages; CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging; Packaging requirement for raw and processed foods and selection of packaging materials; Disposal and recycle of packaging waste.

Package testing- testing methods for flexible materials, rigid materials and semi rigid materials, tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.)

Practical

Identification of different types of packaging materials; Determination of tensile/ compressive strength of given material/ package; To perform different destructive and non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; Measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging material; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package and visit to relevant industries.

Suggested Readings

1. Coles, R., McDowell, D. and Kirwan, M. J. 2003. *Food Packaging Technology*. Blackwell Publishing Co.
2. Gosby, N. T. 2001. *Food Packaging Materials*. Applied Science Publication

3. John, P. J. 2008. *A Handbook on Food Packaging.* Narendra Publishing House.
4. Mahadevia, M. and Gowramma, R. V. 2007. *Food Packaging Materials*. Tata McGraw Hill.
5. Robertson, G. L. 2001. *Food Packaging and Shelf life: A Practical Guide*. Narendra Publishing House.
6. Robertson, G. L. 2005. *Food Packaging: Principles and Practice*. Second Edition. Taylor and Francis.

Food Plant and Equipment Design 3 (2+1)

Objective

To enable the students to

1. Understand the managerial aspects of food processing plant
2. Understand Govt. policy on small and medium scale food processing enterprise
3. Understand the procedure of obtaining license and registration for operating food processing business

Theory

Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams; Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout; Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout.

Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment; Design codes, pressure vessel design; Design of cleaners; Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger; Design of belt conveyer, screw conveyer and bucket elevator; Design of grain dryers; Design of milling equipment; Optimization of design with respect to process efficiency, energy and cost; Computer Aided Design.

Practical

Study of salient features and layout of preprocessing house; Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit; Evaluation of given layout; Design of pressure vessel; Design of cleaners; Design of milling equipment; Design of tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger; Design of grain dryer; Design of belt conveyor, bucket elevator, screw conveyor.

Suggested Readings

1. Bhattacharyya, B. C. 2008. *Introduction to Chemical Equipment Design*. CBS Publishers and Distributors.
2. Dawande, S. D. 1999. *Process Design of Equipment*. Central Techno Publication, Nagpur.
3. Geankoplis, C. J. 1993. *Transport Processes and Unit Operations*. Prentice-Hall.

4. Hall, H. S. and Rosen, Y. S. 1963. *Milk Plant Layout*. FAO Publication, Rome.
5. López Antonio Gómez. 2005. *Food Plant Design*. T&F India.
6. Mahajan, M. 2016. *Operations Research*. Dhanpat Rai and Company Private Limited, Delhi.
7. Mahajani, V. V. and Umarji, S. B. 2009. *Process Equipment Design*. Macmillan.
8. Maroulis, Z. B. and Saravacos, G. D. 2007. *Food Plant Economics*. Taylor and Francis, LLC.
9. Maroulis, Z. B. 2003. *Food Process Design*. Marcel Dekker, Inc, Cimarron Road, Monticello, New York 12701, USA.
10. Robberts Theunis, C. 2016. *Food Plant Engineering Systems*. CRC Press, Washington.

Emerging Technologies in Food Processing 3 (3+0)

Objective

To enable the students to

1. know about various emerging technologies in food processing.
2. know the practical applications of various emerging technologies in food processing.

Theory

Introduction, different emerging technologies and their scope and applications.

Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems, radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies.

Principles and equipment for Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ ionising radiation, Ultraviolet radiation processing.

Pulsed X-ray processing, Pulsed light processing, Cold plasma Processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge.

Nanomaterial utilisation in food processing, manufacture of nanomaterials, applications.

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. *Food Engineering Principles and Practices*. CRC Press
2. Passos and Ribeiro. *Innovation in Food Engineering – New Techniques and Products*. CRC Press
3. Sun Da-Wen. *Thermal Food Processing – New technologies and Quality Issues*. CRC Press
4. SunDa-Wen. *Emerging technologies in food processing*. Elsevier
5. Tewari and Juneja. *Advances in Thermal and Non-Thermal Food Preservation*. Blackwell

Processing of Livestock, Fish and Marine Products 3 (2+1)

Objective

To enable the students to

1. Learn various processes and methods for processing of livestock, fish and marine products
2. Understand the livestock and marine product processing and its applications in industries

Theory

Production, economics, and processing scenario of meat, fish, and poultry; Processing and preservation of eggs, production of egg yolk and egg yellow powder; Poultry processing: Unit operations for various poultry products; Fish processing: Unit operations for various fish products; Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meat using antibiotics and chemical additives; Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing; Abattoir design and layout, meat plant sanitation and safety; By-products utilization.

Practical

Hands on exercise on the processing of fish, meat and egg and preparation of value-added products; Visit to processing plants.

Suggested reading

1. Bechtel, P.J. *Muscle as Food*. Academic Press.
2. Hui, Y. H. *Handbook of Meat and Meat Processing*. CRC Press.
3. Lawrie, R. A. and Ledward, D. *Lawrie's Meat Science*. Woodhead Publishing.
4. Stadelmen, W. J. and Cotterill, O.J. *Egg Science and Technology*. CRC press.

Food Business Management and Entrepreneurship Development 3 (3+0)

Objective

To enable the students to learn various aspects of business management and entrepreneurship development in food processing

Theory

Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development; Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure; Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources; Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector; Government policies for promotion of entrepreneurship in food processing; Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis; Resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management; Case study of a food business.

Suggested Readings

1. Awasthi D and Jaggi R. *Entrepreneurship and Management Inputs for Entrepreneurs in Food Processing Sector*. Ahmedabad EDII
2. Bell, G. F. and Balkwill, J. *Management and Engineering*. Prentice Hall International

3. Bharatia, C. R. *Food Technology and Entrepreneurship Management*. Surendra Publications
4. Jordan, Lisa. *Food Industry: Food Processing and Management.* 2 edn. Callisto

MATLAB Programming 3 (1+2)

Objective

To enable the students to know the different features of MATLAB and have hands-on exercise on it and use the MATLAB for different agricultural engineering applications

Theory

Introduction: platform and features, prerequisites and system requirements, advantages and disadvantages.

Commands, environment, working with variables and arrays, workspace, variables and functions, data types, operator, formatting text.

MATLAB Control Statements: if statement, if-else statement, if-elseif statement, nested if-else, switch.

MATLAB loops: for loop, while loop, nested loop, break, continue.

MATLAB error control: error control statement-try and catch.

Arrays and functions: matrices and arrays, multi-dimensional arrays, compatible array, sparse matrices; Functions: normal functions, predefined functions, user-defined functions, anonymous Function

2D Plots: fplot(), Semilogx(), Semilogy(), loglog(), fill(), Bar(), errorbar(), barh(), plotyy(), area(), Pie(), hist(), stem(), Stairs(), compass(), comet(), contour(), quiver(), pcolor();

3D Plots: plot3(), fill3(), contour3(), surf(), surfc(), mesh(), meshz(), waterfall(), stem3(), ribbon(), sphere(), ellipsoid(), cylinder(), slice()

Practical

Hands on experience with MATLAB functionalities and its installation on different platforms; MATLAB project based on real time Agricultural Engineering problems.

Python Programming 3 (1+2)

Objective

1. To enable the students to know the different features of Python programming and have hands-on exercise on it
2. To use the Python programming for different agricultural engineering applications

Theory

Introduction: history, applications, installation.

Variables, data types, keywords, literals, operators, comments.

Conditional statements: if else, loops, for loop, while loop, break, continue, pass. strings, lists, tuples, list vs tuple.

Functions: functions, built-in functions, lambda functions.

Files I/O, modules, exceptions, date, Regex, read CSV File, write CSV File, read excel file, write excel file, assert, list comprehension, collection.

Module, math module, OS module, random module, statistics module, sys module, IDEs, arrays, command line arguments, stack and queue.

Python OOPs: OOPs concepts, object class, constructors, inheritance, abstraction.

Practical

Hands on experience with Python and its installation on different platforms; Accessing python from GUI and from command prompt / terminal, a project based on real time agricultural engineering problems.

Artificial Intelligence applications 3 (2+1)

Objective

To enable the students to know the details of problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning, communicating, perceiving, and acting in artificial intelligence

Theory

Foundation and history of artificial intelligence; Intelligent agents, structure of agents; AI programming languages, introduction to LISP and PROLOG; Solving problems by searching, problem solving agents, infrastructure for search algorithms, measuring problem solving performance, blind search strategies, breadth first search, depth first search, heuristic search techniques, best first- A* algorithm, AO* algorithm; Hill climbing search, Genetic algorithms; Games, game tree, game playing, min-max algorithms, alpha beta pruning; Logical agents, knowledge representation issues, predicate logic, logic programming; Constraint satisfaction problems, backtracking search; Knowledge representation- representing knowledge using rules, rules based deduction systems, semantic nets, frames, inheritance, temporal reasoning; Quantifying uncertainty, reasoning under uncertainty; Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempstershafer theory, fuzzy reasoning; Classical planning- planning, representation for planning, partial order planning algorithm; Planning and acting in the real world- planning in situational calculus, high-level actions; Supervised learning, artificial neural networks, neural network structures, single-layer feed-forward neural networks (perceptron), multilayer feed-forward neural networks, learning in multilayer networks; Knowledge in learning- a logical formulation of learning, explanation-based learning; Natural language processing- principles of natural language processing; Expert systems, knowledge acquisition concepts; Robotics, AI application to robotics; Current trends in intelligent systems.

Practical

Hands on exercise on problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning in artificial intelligence, communicating, perceiving, and acting in artificial intelligence and verifying engineering concepts in artificial intelligence.

Suggested Readings

1. Nilson, N. J. 2002. *Principles of Artificial Intelligence*. Narosa Publishing House.
2. Rich, E. and Knight, K. 1991. *Artificial Intelligence*. Times McGraw-Hill.
3. Russell, S. and Norvig, P. 1998. *Artificial Intelligence: A Modern Approach*. Prentice Hall.
4. Winston, P. H. 1992. *Artificial intelligence*. Addition Wesley 3rd edn.

Advances in Automation and Robotics in Agriculture 3 (2+1)

Objective

To enable the students to gain advanced knowledge and skill for application of automation and robotics in agriculture, know about the modelling of robot mechanisms, robot control architectures and robot design and considerations for agricultural operations

Theory

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyperspectral sensor, Stereo vision system, Optical flow sensor, GPS sensor-RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty.

Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy), Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments, Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior-based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry.

Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms. Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geofencing, Triggering, Software for robot control and navigation, Probabilistic Robot Localization- Localization, Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture-Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages; Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction.

AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns -Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system.

Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practical

Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modelling; PID control of actuators and their calibration for precise control; Practical on robot actuator control systems for determination of mass, inertia, friction, and forces; Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software; Sensor-driven robot control for obstacle avoidance using different sensors; Calibration of GPS sensors and 3-D fixing for precise control; Robot control architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body, etc; Robot design consideration for sowing and transplanting operation; Robot design for weeding operation; Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops; Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms; Robots for variable rate application of agricultural inputs; Driverless and autonomous tractor for straight control calibration of movement; Control of humanoid robots for selected agricultural operations and active voice command control.

Suggested Readings

1. Ben-Ari, Mordechai and Mondada, Francesco. *Elements of Robotics*. Springer Nature, 2017.
2. Bräunl, T. *Embedded Robotics Mobile Robot Design and Applications with Embedded Systems*. Springer Berlin Heidelberg, 2013.
3. Craig, John J. *Introduction to Robotics Mechanics and Control*. 5 Pearson Education, Inc. Pearson Prentice Hall Pearson Education, Inc. Upper Saddle River, NJ, 2005.
4. Miller, Mark R. and Miller, Rex. *Robots and Robotics, Principles, Systems, and Industrial Applications*. McGraw-Hill Education, 2017.
5. Schilling, Robert. J. *Fundamentals of Robotics – Analysis and Control*. Prentice Hall of India,1990.
6. Siegwart, Roland, Nourbakhsh, Illah Reza and Scaramuzza, Davide. *Introduction to autonomous Mobile Robots*. MIT press, 2011.
7. Zhang, Dan, and Bin Wei, eds. Robotics and mechatronics for agriculture. CRC Press, 2017.

Machine Learning 3 (2+1)

Objective

To enable the students to

1. Know the basics of machine learning
2. Know the applications of machine learning in different fields

Theory

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bia, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods; Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems; Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation.

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, Vapnik Chernonenkis dimension, linear dichotomies and capacity. Unsupervised learning, clustering methods based on Euclidian distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Practical

Hands on experience with Machine Learning functionalities and its use in agricultural engineering and allied fields.

Suggested Readings

1. Ethem, Alpaydin. 2009. *Introduction to Machine Learning*. 3rd edn. MIT Press.
2. Muller, Andreas C. 2009. *Introduction to Machine Learning with Python- A Guide for Data Scientists*. Sarah Guido, O'Reilly
3. Muller, J P. and Massaron, L. 2021. *Machine Learning for Dummies*. 2nd edn. Weily.

Operations Research 3 (3+0)

Objective

To enable the students to

1. Understand the importance of operations research for solving field problems
2. Understand and apply linear programming, transportation problem, etc. for agricultural engineering applications
3. Understand the project planning and network analysis

Theory

Introduction to operations research: elementary concepts and objectives, applications of operations research in decision making; Linear programming problem- mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions; Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem, introduction and mathematical formulation, solution of Assignment problem; Inventory control, introduction and general notations, economic lot size models with known demand; Replacement theory, introduction and elementary concepts, replacement of items deteriorating with

time; Sequencing problem: introduction and general notations, solution of a sequencing problem; Queuing theory: introduction and classification of queues, solution of queuing models; Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT).

Suggested Readings

1. Taha, H. 2003. *Operations Research*. Macmillan Publishing Company.
2. Winston, W. L. 2004. *Operations Research: Applications and Algorithms*. Indian University.

Mechatronics 3 (2+1)

Objective

To enable the students to

1. Know the measurement system, control systems, microprocessor-based controllers of A.C. & D.C. motor
2. Understand the principles behind the working of different data acquisition, digital signal processing
3. Know the different application of microcontrollers, PLC. robotics, robot components, robot classification and specification

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach; Sensors and transducers- performance terminology, displacement, position and proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers;

Actuators and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems.

System modelling and control- mathematical models, engineering systems, electro-mechanical and hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes and PID controller.

Micro-processor and computer- computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC, robotics, robot classification and specification, robot components, work envelopes, other basic parameters of robots, robot applications, robot applications in manufacturing, material transfer and machine loading/ unloading, processing operations like welding and painting, assembly operations, inspection, automation, future applications.

Practical

Study of different types transducers; Selection of sensor for a particular application from catalogue and internet; Design of a mechatronics product/ system; Application of mechatronics for

enhancing product values; Study of electrical actuation systems with A.C. Motor and with D.C. Motor; Study of electrical actuation systems with Stepper Motor; Study of the PID Controller; Study of the hardware and software of mechatronics kit; Study of the pulse modulation, data presentation systems; Moving a table in X-direction within the range of proximity sensors using Control-X software; Running a motor with PLC; Running a conveyor with computer; Study of the movement of actuating cylinders and sensors.

Suggested Readings

1. Bolton, W. 2015. *Mechatronics*. Pearson Education Asia.
2. Craig, J. J. 1986. *Introduction to Robotics*. Pearson Education International.
3. Doeblin, E. O. 1966. *Measurement Systems*. McGraw-Hill Inc.
4. Malvino, A. P. 1983. *Digital Computer Electronics*. McGraw-Hill Inc.
5. Niku, S. Y. 2001. *Introduction to Robotics: Analysis, systems and Applications*. Pearson Education International.
6. Stadler, W. 1995. *Analytical Robotics and Mechatronics*. McGraw-Hill Inc.

Natural Fibres: Extraction and Properties 3 (2+1)

Objective

To enable the students to

1. Importance of natural fibres and the quality management of natural textile fibres
2. Understand the properties of different types of natural fibres and their extraction methods
3. Understand the different equipment involved in natural fibres extraction

Theory

Introduction to Natural Fibres: Natural fibres definition, Detailed Classification; Natural fibres–physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres; Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres.

Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application; Jute: Cultivation- Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application.

Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting.

Physical Properties of Natural fibres: Fibre Morphology; Fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre, Fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behavior; Mechanical Properties:

Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practical

Identification of natural fibres; Extractions of jute, cotton, flax, banana, sisal and ramie; Retting of Jute and Flax; Quality evaluation of jute and other fibres; Determination of mechanical and insulation properties.

Suggested Readings

1. Cook, J. G. 2005. *Hand Book of Textile Fibers*. Wood Head Publishers, London, Vol 1 & 2
2. Corbmann, P. B. 2001. *Textile Fiber to Fabric*. Mc Graw-Hill International Education, 6th edn.
3. Gohl and Vilensky. 2003. *Textile Science*. 2nd edn. Mahajan Book Publishers,
4. Mishra, S.P. 1998. *Fibre Science and Technology*. New Age India International Ltd. New Delhi.
5. Shenai, V. A. 2004. *Technology of Textile Processing- Textile Fibers*. Sevak Publications.
6. Sreenivasa Murthy, H.V. 1994. *Introduction Textile Fibres*. Textile Association of India, Bombay.
7. Tammanna and Sonwalkar, N. 2002. *Handbook of Silk Technology*. Wiley Eastern Limited, New Delhi.

Natural Fibre Applications in Agriculture 3 (2+1)

Objective

To enable the students to

1. Know the different applications of natural fibres such as in soil and water conservation, packaging, energy production and soil less farming, etc.
2. Understand the economics of using natural fibres for these applications

Theory

Natural Fibre based Agrotextiles, Characterization and their application: Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles, Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population, Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies, Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir's equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor),Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce, Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based packaging, natural fibre-based reaper binder, Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging.

Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification, Economic and environmental analysis of natural fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol).

Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost, Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Practical

Preparation of woven and nonwoven fabrics; Estimation of different mechanical and hydro-physical properties; Agro-textile field trial/experiment; Natural fibre-based Packaging; Production of energy from natural fibres.

Suggested Readings

1. Blackburn, R. S. (Ed). 2009. *Sustainable Textiles: Life Cycle and Environmental Impact*. Woodhead Publishing. ISBN 978-1-84569-453-1.
2. Cheng, H. N., Byron, A. E. and Okos, M. R. (Eds). 2017. *Sustainable Fiber-Based Packaging*. John Wiley & Sons. ISBN: 978-1-119-17306-4.
3. Fangueiro, R. and Rana, S. (Eds). 2016. *Natural Fibre Composites in Geotextiles: Design and Applications*. Woodhead Publishing. ISBN: 978-0-08-100215-7
4. Hakeem, K. R., Jawaid, M., and Alothman, O. Y. (Eds). 2019. *Biomass and Bioenergy: Processing and Properties*. Springer. ISBN: 978-981-13-8562-2.
5. Hardin, M. R. (Ed.). 2007. *Natural and Artificial Fiber Nonwoven Textiles*. CRC Press. ISBN: 978-0-8493-6454-9.
6. Kozłowski, Ryszard M. (Ed). 2012. *Handbook of natural fibres. Volume 2: Processing and applications.* Woodhead Publishing Limited. ISBN 978-1-84569-698-6.
7. Tripathy, R.P. and Singh, H.P. (Eds). 1993. *Soil Erosion and Conservation*. New Age International (P) Limited, Publishers. ISBN: 81-224-0305-0.

Processing of Natural Fibres 3 (2 + 1)

Objective

To enable the students to

1. Understand the chemical composition of natural fibres and their conversion methods
2. Understand the different mechanical and chemical processing methods of natural fibres
3. Know about the different value addition methods for natural fibres

Theory

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending.

Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.

Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom; shedding, picking, Beat-up, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.

Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.

Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing; Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.

Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practical

Basic concepts of spinning; Manufacture of yarn from natural fibres; Practical on weaving and knitting; Yarn and fabric testing; Pre-treatments of natural fibres; Bleaching and dyeing of natural fibres; Finishing of natural fibres.

Suggested reading

1. Booth J. E. 1996. *Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics*. 6th edn. London: Newnes Butterworths
2. Brown, R. 1978. *Weaving, Spinning and Dyeing Book*. London: Routledge and Kegan Paul.
3. Cegarra, J. P. and Valladperas, J. 1992. *The Dyeing of Textile Manual, the Scientific Bases and the Techniques of Application.* Italy: NecovaOflito.
4. Corbman, B. P. 1983. *Fibre to Fabric step by Step Weaving.* 6th edn. New York: McGraw Hill.
5. David G, Sinclair, Roy, S. 1989. *Giles Laboratory Course in Dyeing.* 4th edn. London: Society of Dyers and Colourist.
6. Eichhorn SJ, Hearle JWS, Jaffe M, and Kikutani T. 2009. *Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres,* Volume 1 in Woodhead Publishing Series in Textiles.
7. Fannin and Allen, A. 1979. *Handloom Weaving Technology*. New York: Van Nostrand Reinhold.
8. Jarman, C. 1998. *Plant Fibre Processing: A Handbook*. eBook 9781780442990, pp.64
9. Ponting, K. G. 1981. *A Dictionary of Dyes and Dyeing*. London: Bell and Hymen Ltd.
10. Rouette, H. K. 2001. *Encyclopaedia of Textile Finishes*. Berlin: Springer Verlag.
11. Saville, B. P. 1999. *Physical Testing of Textiles*. Woodhead publication. CRC Press.
12. Shenai, V. A. 1985. *Technology of Dyeing: Technology of Textile Processing.* Vol. VI. Sevak Publication.
13. Shenai, V. A. 1985. *Technology of Printing: Technology of Textile Processing.* Vol. IV. Sevak Publication.

Agricultural Marketing and Trade 3 (2+1)

Objective

To enable the students to

1. understand the fundamentals of agricultural marketing and trade
2. analyze the factors influencing supply and demand in agricultural markets
3. explore different marketing channels and strategies in agriculture
4. examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control

and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

- Acharya, S.S. and Agarwal, N.L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chinna, S. S. 2005. *Agricultural Economics and Indian Agriculture.* Kalyani Pub, N Delhi.
- Dominic Salvatore. *Micro Economic Theory.*
- Kohls Richard, L. and Uhl Josheph, N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi.
- Kotler and Armstrong. 2005. *Principles of Marketing*. Pearson Prentice-Hall.
- Lekhi, R. K. and Singh, J. 2006. *Agricultural Economics*. Kalyani Publishers, Delhi.
- Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi.
- Pandey, M. and Tewari, D. 2004. *Rural and Agricultural Marketing.* International Book Distributing Co. Ltd, New Delhi.
- Sharma, R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

SKILL ENHANCEMENT COURSES

(Indicative Activities/ Learning areas)

Operation and Maintenance of Farm Machinery 4 (0+4)

- Constructional details, adjustment and working of primary tillage equipment such as mould board plough and disc plough
- Constructional details, adjustment and working of secondary tillage equipment such as cultivators, harrows
- Constructional details, adjustment and working of weeding equipment such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculture equipment
- Constructional details, adjustment and working of rotary tillage / active tillage equipment such as tractor operated /power tiller operated rotavator
- Constructional details, adjustment and working of sowing equipment such as seed drills, planters and transplanters, minimum tillage equipment
- Adjustments and calibration of seed drills
- Working with different types of furrow openers with seed drills/ planters
- Constructional details, adjustment and working of metering mechanisms of drills and planters
- Details of precision farm equipment such as laser levelers, zero till drills, pneumatic planters etc.
- Constructional details, adjustment and working with earth moving equipment such as bulldozers, trenchers and elevators, etc.
- Constructional details, adjustment and working of transplanting equipment such as rice transplanters and vegetable transplanters
- Seedling raising technique for transplanters
- Constructional details, adjustment and working of irrigation equipment such as different types of pumps, sprinkler irrigation system/drip irrigation system
- Constructional details, adjustment and working of harvesting equipment such as root crop harvesters (bullock drawn as well as tractor operated groundnut diggers) and grain crop harvesters (self-propelled / tractor operated/ power tiller operated vertical conveyer reapers) etc.
- Constructional Details, adjustment and working of threshing equipment such as axial flow paddy threshers, combine harvesters etc.

Repair and Maintenance of Tractors and Power Tillers 4 (0+4)

- Study of different systems of tractor and power tiller
- Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval, firing order
- Study of fuel system, working principle, repair and maintenance
- Working of fuel pumps, fuel filters and injectors
- Study of lubrication system, working principle, repair and maintenance

- Working of oil filters, oil pumps etc.
- Study of cooling system, working principle, repair and maintenance
- Working of thermostat valve
- Study of tractor/ power tiller engine system
- Study of power transmission system of tractor/ power tiller (different types of clutches/gears/ sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller)
- Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance
- Study of braking system: different types of brakes/ their components and working principle/ adjustment / repair
- Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance
- Steering in power tiller: Dog clutch and other arrangements
- Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance
- Study of tyres, rims, their construction and specification, repair and maintenance
- Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation
- Engine overhauling and assembling.
- Implement hitching and detaching from tractor as well as power tiller
- Safety rules

Management of Agricultural Machinery Custom Hiring and Maintenance Facilities 4 (0+4)

- Terms associated with machinery management for correct understanding
- Different ways machinery can be obtained for use on the farm
- Factors that affect the purchase of machinery
- Advantages and limitations of two-wheel drive tractors
- Advantages and limitations of four-wheel drive tractors
- Calculation of the theoretical capacity of a farm machines
- General rules concerning field efficiency
- Calculation of field capacity of a farm machines
- Distinguishing between types of costs of machinery ownership
- Understanding how cost and machine use are related
- Calculation of salvage value of a farm machine
- Calculation of average machine investment of a farm machine
- Calculation of annual fixed cost of a farm machine
- Calculation of repair cost for a farm machine
- Calculation of fuel and lubrication costs for a tractor
- Calculation of labor cost for a farm machine

- Understanding causes of fatal tractor accidents
- Learning of procedures for safe machine operation
- Understanding the reasons for efficiency in tractor operation
- Preventative maintenance of farm Machinery
- List five areas of servicing machinery
- Calculate estimated variable cost of a farm machine
- Calculate overall cost per acre for farm machinery
- Calculate equipment width (size) to match tractor horsepower

Fabrication, Operation and Maintenance of Renewable Energy Gadgets 4 (0+4)

- Acquaintance with different renewable energy sources (solar, wind, hydro, biomass, geothermal)
- Principles of photovoltaic (PV) technology, fabrication processes for solar panels and Installation and maintenance of solar power systems
- Grid-tied vs. off-grid solar systems
- Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms
- Pico hydro and their construction and maintenance
- Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion)
- Fabrication of biomass energy systems like gasifier, Improved challah, etc.
- Routine maintenance procedures for renewable energy systems, Troubleshooting common issues
- Safety protocols for maintenance tasks; Monitoring and performance optimization
- Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning
- Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.)
- Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes

Operation and Maintenance of Drones Used for Agricultural Applications 4 (0+4)

- Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations
- Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles
- Introduction to various sensors used in agricultural drones (RGB cameras, multispectral cameras, thermal cameras, LiDAR, etc.)
- Applications of different sensors in agriculture (crop monitoring, pest detection, irrigation management, etc.), Payload integration and compatibility considerations

- Principles of flight planning for agricultural drone missions, Selection of appropriate flight parameters (altitude, speed, overlap, etc.), Use of mission planning software and tools, Pre-flight checks and safety protocols
- Techniques for data acquisition during drone flights, Post-flight data processing and analysis, Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization
- Applications of drones in crop monitoring (plant health assessment, yield estimation, disease detection, etc.), Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data
- Using drones for early pest and disease detection, Identification of common pests and diseases in crops, Monitoring strategies for pest infestations and disease outbreaks
- Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology
- Routine maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.), Battery management and care
- Safety protocols for drone operations in agricultural settings, Understanding airspace regulations and restrictions, Emergency procedures and risk mitigation strategies
- Real-world examples of successful drone applications in agriculture, Hands-on exercises and field demonstrations
- Challenges and opportunities for the widespread adoption of drone technology in agriculture, Ethical and societal implications of drone use in farming

Machine Vision, Sensors and Sensor Architectures **4 (0+4)**

- Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis
- Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc.
- Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications
- Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.)
- Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc.
- Considerations in sensor selection and integration for specific applications
- Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation
- Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control

- Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.)
- Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc.
- Applications of 3D vision in robotics, metrology, object recognition, etc.
- Examples of multisensor systems in real-world applications
- Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms
- Case studies of IoT applications in agriculture
- Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.)
- Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems
- Applications of embedded vision in autonomous vehicles, drones, consumer electronics, etc.
- Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field
- Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost reduction, etc.), Ethical and societal implications of widespread sensor deployment and data collection

Design of Solar PV Systems Using Softwares **4 (0+4)**

- Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares
- Features for designing a solar PV system (location, load requirements, shading analysis, etc.), Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.
- Conducting a site analysis to assess the solar potential and available space for PV system installation, using software tools to perform shading analysis and identify potential obstructions or shading issues
- Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components. Optimizing the system configuration to maximize energy production and efficiency
- Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations
- Designing the electrical wiring and connection scheme for the PV array, inverters, and other components
- Running simulations to estimate the performance and energy yield of the proposed PV system, analyzing simulation results to evaluate the system's energy production, capacity factor, and financial viability

- Fine-tuning system parameters to optimize performance and maximize energy output
- Performing a financial analysis to assess the economic feasibility of the solar PV project, Calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics, Considering incentives, subsidies, and financing options for solar PV installations
- Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency, system size, electricity tariffs) on project economics, iteratively refining the system design to achieve the desired performance and economic outcomes
- Generating detailed reports and documentation summarizing the design process, simulation results, and project economics
- Case studies based on real-world projects to apply learned concepts and techniques
- Addressing common challenges and troubleshooting issues encountered during the design process.

Installation and Maintenance of On-Grid and Off-Grid Solar Systems 4 (0+4)

- Overview of solar photovoltaic technology and its applications, Explanation of on-grid and off-grid solar systems
- Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.)
- Understanding the differences between on-grid and off-grid system configurations
- Component identification and system layout design
- Conducting site assessments to determine solar potential and suitability for PV system installation. Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components
- Installation of solar panels, inverters, and other components for on-grid systems, Techniques for mounting solar panels on rooftops or ground-mounted structures
- Wiring and connection of components to the electrical grid
- Setting up off-grid solar systems, including battery-based energy storage, Installation of charge controllers, batteries, and DC loads
- Designing and configuring off-grid systems for reliable and efficient operation
- Electrical wiring practices for solar PV systems
- Understanding safety precautions and regulations related to electrical installations
- Wiring solar panels, inverters, charge controllers, and battery banks
- Commissioning and testing of solar PV systems to ensure proper functionality, conducting performance tests and verifying system parameters
- Troubleshooting common issues and addressing installation errors
- Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components
- Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration

- Techniques for integrating additional solar panels, batteries, or other components into existing systems
- System modification and expansion
- Introduction to remote monitoring systems for tracking the performance of solar PV systems, using data analytics tools to diagnose issues and optimize system performance, Hands-on practice in accessing system data and interpreting performance metrics

Design and Maintenance of Agrivoltaic Systems **4 (0+4)**

- Overview of agrivoltaic systems and their benefits, Explanation of how solar panels and agriculture can coexist synergistically
- Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.), Conducting site assessments to determine solar potential and suitability for agricultural activities
- Design principles for integrating solar panels with agricultural crops or livestock, Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield
- Selection of appropriate crops and planting strategies for agrivoltaic systems
- Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture
- Safety protocols and best practices for working with solar panel arrays
- Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health
- Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions
- Designing the electrical layout for connecting solar panels to the grid or off-grid systems, Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards
- Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance
- Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions, Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns
- Overview of regulations, permits, and incentives related to agrivoltaic installations, Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics
- Visits to agrivoltaic installations and research sites for hands-on learning opportunities, Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field

Valorisation of Agri-biomass and Organic Waste **4 (0+4)**

- Concept of valorization and its role in waste-to-value processes, Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production

- Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.), Understanding the properties and potential uses of different types of biomass and waste materials
- Sample collection, preparation, and analysis
- Introduction to biological conversion methods such as anaerobic digestion and composting, Principles of microbial decomposition and fermentation in biomass conversion
- Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing, Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes
- Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion
- Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.)
- Valorization of agri-biomass and organic waste into value-added products such as biochar, bio-based chemicals, and biomaterials
- Strategies for waste minimization, reuse, and recycling in agricultural and food production systems
- Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts
- Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste

Energy audit, Energy Conservation and Energy Efficiency **4 (0+4)**

- Key concepts and definitions related to energy conservation and efficiency
- Introduction to the principles of energy auditing and analysis
- Methods for collecting and analyzing energy consumption data
- Interpretation of energy bills, utility data, and meter readings
- Conducting energy audits for residential, commercial, and industrial facilities
- Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras)
- Use of software tools for energy data analysis and visualization
- Identifying potential areas for energy savings and efficiency improvements, Evaluation of building systems, equipment, and operations
- Hands-on exercises in identifying ECOs through site inspections and data analysis
- Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects
- Analysis of building energy performance using energy modelling software
- Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures

- Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels
- Energy efficiency standards, labeling programs, and building codes
- Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis
- Use of measurement and verification (M&V) protocols and reporting

Repair and maintenance of pumps and irrigation systems **4 (0+4)**

- Acquaint with different pumps and motors used in irrigation system
- Study of various water lifting devices and their limitations
- Study of components of centrifugal pump and its function
- Study of components of submersible pump and its function
- Components of reciprocating pump and its function
- Dismantling and assembling of irrigation pumps
- Performance testing of centrifugal pumps
- Preparation of pump housing
- Pump alignment and troubleshooting
- Knowing different accessories for electric pump
- Winding of 3-phase and single-phase electric motor
- Causes of trouble shooting in electrical pump set and their remedial measures
- Dismantling and assembling of diesel pump set
- Causes of trouble shooting in diesel pump set and their remedial measures
- Regular maintenance and overhauling, lubrication of pumps
- Study of solar pump set, and its components
- Step-wise installation of solar pump set including earthing

Installation and maintenance of micro irrigation systems **4 (0+4)**

- Acquaint with different components of micro irrigation
- Installing of micro irrigation (both drip and micro sprinkler) system
- Design of micro irrigation system (both drip and micro irrigation) in field
- Computation crop water requirement of crops
- Acquaint with fertigation equipment, their operation and maintenance
- Execution of fertigation with water soluble fertilizers
- Fixation of fertigation equipment with micro irrigation system
- Doing maintenance schedule in micro irrigation
- Operating automated micro irrigation system
- Operating IOT based irrigation system

Application of Remote Sensing and GIS for Agricultural Water Management **4 (0+4)**

- Basics of remote sensing

- Remote sensing sensors and platforms
- Introduction to GIS
- Types of projection systems
- Study of Image resolutions and coordinate system
- Source of remote sensing data and accessibility
- Operations in Google earth platform
- Introduction to basic modules of ArcGIS
- Introduction to basic modules of QGIS
- Georeferencing, rectification, digitization and shape file creation
- Basic raster/vector data operations
- Map projection and re-projection
- Preparation of contour maps and rainfall Thiessen polygons
- Map layout and styling
- Preparation of various vegetation index maps
- Preparation of various wetness index maps
- Delineation of watershed and derivation of morphological parameters

Operation and Maintenance of Hydro-meteorological Instruments **4 (0+4)**

- Study and operation of Weather Monitoring Instruments: Thermometer, Barometer, Hygrometer; Anemometer, Pyranometer and others
- Components of an automatic weather station (AWS)
- Installation of AWS and its maintenance
- Calibration and installation of Tipping bucket raingauge
- Installation of open pan evaporimeter and periodic maintenance
- Study of infiltration process using ring infiltrometer
- Measurement of flow in open channels using various methods
- Study of different weirs and flumes for flow measurement
- Installation of weirs and flumes in the channel
- Measurement of soil moisture using gravimetric method
- In-situ measurement of soil moisture using different soil moisture sensors
- Installation of digital water level recorder (DWLR)
- Measurement of groundwater level using ground water level recorder
- Study of multi-slot divisor and Coshocton wheel silt sampler for measurement of soil loss
- Measurement of flow velocity using digital current meter
- Procedure for recording field observations
- Troubleshooting of hydro-meteorological instruments

Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well (0+4)

- Learn about different features of groundwater system
- Study of different types of geophysical survey
- Components of a resistivity meter
- Wenner-Schlumberger arrangement and comparison
- Process of geophysical survey in field
- Surveyed data analysis and interpretation
- Different types of well log and preparation of commonly used well log
- Study of different types of wells
- Study the components of a tube well/ bore well
- Study of different types of drilling methods/ equipment
- Installation of well assembly: types of casing, screen
- Study on gravel packing
- Study of well development process
- Sanitary protection of tube wells

Installation and Maintenance of Rooftop Rainwater Harvesting System 4 (0+4)

- Survey and site selection for RRWH
- Computation of rooftop RWH potential and runoff coefficient
- Study of components of RWH system
- Catchments: grading and plastering of rooftop
- Coarse mesh, gutters; roofing materials
- Conduit: material, size of conveyance pipe
- Types of filter system used in RWH system
- Study of storage tank: capacity, overflow pipe
- Study of suitable recharge structure for groundwater
- Study of constructional details of recharge pits, recharge trench
- Types of contaminants in RWH system
- Hand pumps and its application in RWH system
- Preparation of Detail Project Report

Operation and Maintenance of Soil Conservation Structures 4 (0+4)

- Survey for slope, stream order and land use/land cover
- Site selection of soil conservation structures based on survey
- Ground truthing of various structures
- Study of different types of soil conservation structures
- Trenching and diversions structures

- Study of types bunding and its features
- Study of types of terracing and its features
- Study of drop spill way: components, function, site suitability
- Study of drop inlet spillway: components, function, site suitability
- Study of chute spillway: components, function, site suitability
- Study of check dams- construction, site suitability
- Study of construction materials of different structures
- Cost estimation of different conservation structures
- Preparation of Detail Project Report

Construction, Management and Maintenance of protected cultivation structures 4 (0+4)

- Study of different protected structures and their uses
- Acquaint with different components of protected structures
- Construction of different protected structures
- Study of glazing materials and their properties
- Selection of different construction materials and their specifications
- Management of micro climate parameters in protected structures
- Monitoring of micro climate inside protected structures
- Automatic monitoring of micro climate inside protected structure
- Use of Irrigation and fertigation in protected cultivation
- Visit to different hydroponics systems under protected structures

Agro Processing Methods, Equipment Operation and Maintenance 4 (0+4)

- Acquaintance with different unit operations involved in agro-processing
- Cleaning and grading of agricultural commodities: operation and maintenance of different cleaners, graders and destoners
- Operation and maintenance of dehusker, dehuller, degermer and dryer
- Operation and maintenance of rice milling machineries
- Operation and maintenance of dal mills and oil mill
- Operation and maintenance of flour mills and pulverisers
- Operation and maintenance of boiler, pasteurizer and sterilizer
- Operation and maintenance of peeler, slicer, pulper and juicer
- Operation and maintenance of canning machineries
- Operation and maintenance of packaging machineries

Operation and Management of Multi-Commodity Agro-Processing Centre 4 (0+4)

- Acquaintance with different agro-processing models
- Site selection, plant layout and project report preparation
- Manufacturing and management of primary processing centre

- Preparation of grain, pulse and oilseed- based products and acquaintance with operation of different equipment
- Preparation of products using flour mill
- Spice processing and acquaintance with operation of different equipment
- Operation and management of fruit and vegetable pack house
- Preparation of different fruit- based products and acquaintance with operation of different equipment
- Preparation of different vegetable- based products and acquaintance with operation of different equipment
- Manufacturing of snack foods
- Acquaintance with food safety and hygiene, and certifications
- Record keeping, inventory, finance and human resource management for agro-processing

Primary Processing and Value Addition and Cold Chain Logistics **4 (0+4)**

- Primary processing of fruits and vegetables
- Operation and maintenance of washer and graders
- Study of refrigeration system and freezing equipment
- Operation of precooling systems
- Operation and maintenance of cold storage and solar cold room
- Operation and maintenance of ripening chamber
- Cool chain logistics and cold transport: chilled transport van, semi chilled transport, refrigerated van system
- Cooling systems/ cold chain technology: Gel pack, dry ice, liquid nitrogen, eutectic plates, reefers, cold chain standards and regulations
- Supply chain management systems planning, sourcing, manufacturing, delivering, returning, types of SCM models
- Supply chain logistics, contract logistics

Food Grain Godown and Warehouse Management **4 (0+4)**

- Conversant with technical terms of grain storage, measurement of temperature, relative humidity, grain sampling and moisture content measurement, grain quality
- Acquaintance with different factors for grain deterioration during storage and main insects of stored commodities
- Acquaintance with warehouse equipment and different storage structures
- Cleaning, drying and aeration of stored products
- Determination of dimension of warehouse for bag storage
- Acquaintance with constructional features, maintenance, sanitation and hygiene of warehouses
- Study on integrated pest management, chemical and non-chemical pest and rodent control measures in grain storage system

- Detection methods of insect infestation in food grains and prevention and control of storage fungi
- Acquaintance with inventory, logistics, and collateral management
- Guideline for procurement and disposal of food grains
- Quality control of food grains

Post-harvest Value Chain Management Including Logistics **4 (0+4)**

- Understanding the concept of post-harvest value chain
- Study of existing supply chain of different commodities
- Case study and analysis of value chain of food grains
- Case study and analysis of value chain of horticultural commodities
- Sourcing and material management
- Handling, packing and storage of agricultural commodities
- Transportation and marketing of agricultural commodities
- Ware house management
- Cold storage management
- Cold chain logistics and supply chain management system
- Quality management and tracking food supply chain

ONLINE COURSES

The students will have to take a minimum of 6 credits of online courses, (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Agricultural Engineering) program.

The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. These can be taken any time during the 3rd and 4th years of the UG programme.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

BIOTECHNOLOGY

Course Curricula for Undergraduate Programme in Biotechnology UG-Certificate in Biotechnology UG-Diploma in Biotechnology B. Tech. Biotechnology

INTRODUCTION

Biotechnology encompasses a range of tools and techniques aimed at comprehending the molecular biology of plants and animals to facilitate precise enhancements. Recent advancements in these methodologies have enabled remarkable progress in manipulating macromolecules such as DNA, RNA, and proteins, ultimately benefiting both plants and animals. It is crucial to equip undergraduates with skills in Biotechnology to address the increasing global demand. Recognizing this need, the VI Deans" Committee has undertaken the task of restructuring the Biotechnology course curriculum. The core tenets of the National Education Policy (NEP) have been integrated into the curriculum. Alongside fundamental coursework, students now have access to Skill Enhancement Courses (SECs), which are meticulously crafted to instill proficiency in various facets of Biotechnology. Furthermore, a *Deeksharambh* (Foundation Course) along with the Multi-Disciplinary Courses (MDCs), Value Added Courses (VAC), Ability Enhancement Courses (AECs) and internships have been included. During their final year (first semester of fourth year), students will have the flexibility to select elective courses. These elective courses are structured around four primary themes: Plant Biotechnology, Animal Biotechnology, Microbial and Environmental Biotechnology, and Bioinformatics.

This report reflects the outcomes of extensive consultations and discussions with Deans' and educators from diverse Universities across the country. It is my earnest belief that students will immensely benefit from the amalgamation of theoretical knowledge and practical skills embedded within these restructured program.

Highlights

- The B.Tech. (Biotechnology) program is designed over 4 years, covering 167 credit hours of coursework. Additionally, students to register in 4 credit hours of non-gradial courses and 10 credit hours of MOOCs/Online Courses.
- The coursework consists of 112 credit hours, comprising 80 credits in major courses (including 20 credit hours of elective courses) and 32 credits in minor courses, 9 credit hours of MDC, 6 credit hours of VAC, 8 credit hours of AEC, 12 credit hours of SEC, and 20 credit hours of student READY activities. Two credit hours of non-gradial courses and 10 credit hours of (massive open online courses) MOOCs/Online Courses.
- Upon completing the first year and undertaking a 10-credit (10-week) industry/institute training or internship, students qualify for the first-level exit with a UG-Certificate in Biotechnology. However, students advancing to the second year of the program will not participate in this industry or institute training/internship.
- Upon completing the first and second years and undertaking a 10-credit (10-week) industry/institute training or internship, students are eligible for the second level exit with a UG-Diploma in Biotechnology. However, students progressing to the third year of the program will not participate in this industry or institute training/internship.
- During the fifth and sixth semesters in the third year, the students will be offered with specialized and advanced courses in Biotechnology and related disciplines. In the fifth semester, students participate in an Educational Tour spanning two weeks (10-14 days), designated as a non-gradial course.
- A selection of courses categorized under four elective themes is proposed to provide a total of 20 credits in the seventh semester. Institutes may choose to adjust this selection to include additional specialized and advanced courses in areas such as Plant Biotechnology, Animal Biotechnology, Microbial and Environmental Biotechnology, and Bioinformatics.
- In the eighth semester, the student READY including in-plant training (RAWE/industry attachment/experiential learning/hands on training/project work/internship) will be taken up by the students.
- Students will enroll MOOCs/Online Courses totaling 10 credit hours during the four years (preferably during the third and fourth years) through approved portals with prior notification to the Head of the Institution.

Entry and Exit Options

The entry and exit options for the UG program in Biotechnology are shown in the Figure 1.

*Equivalent programme as decided as per the norms of University /UGC/ICAR.

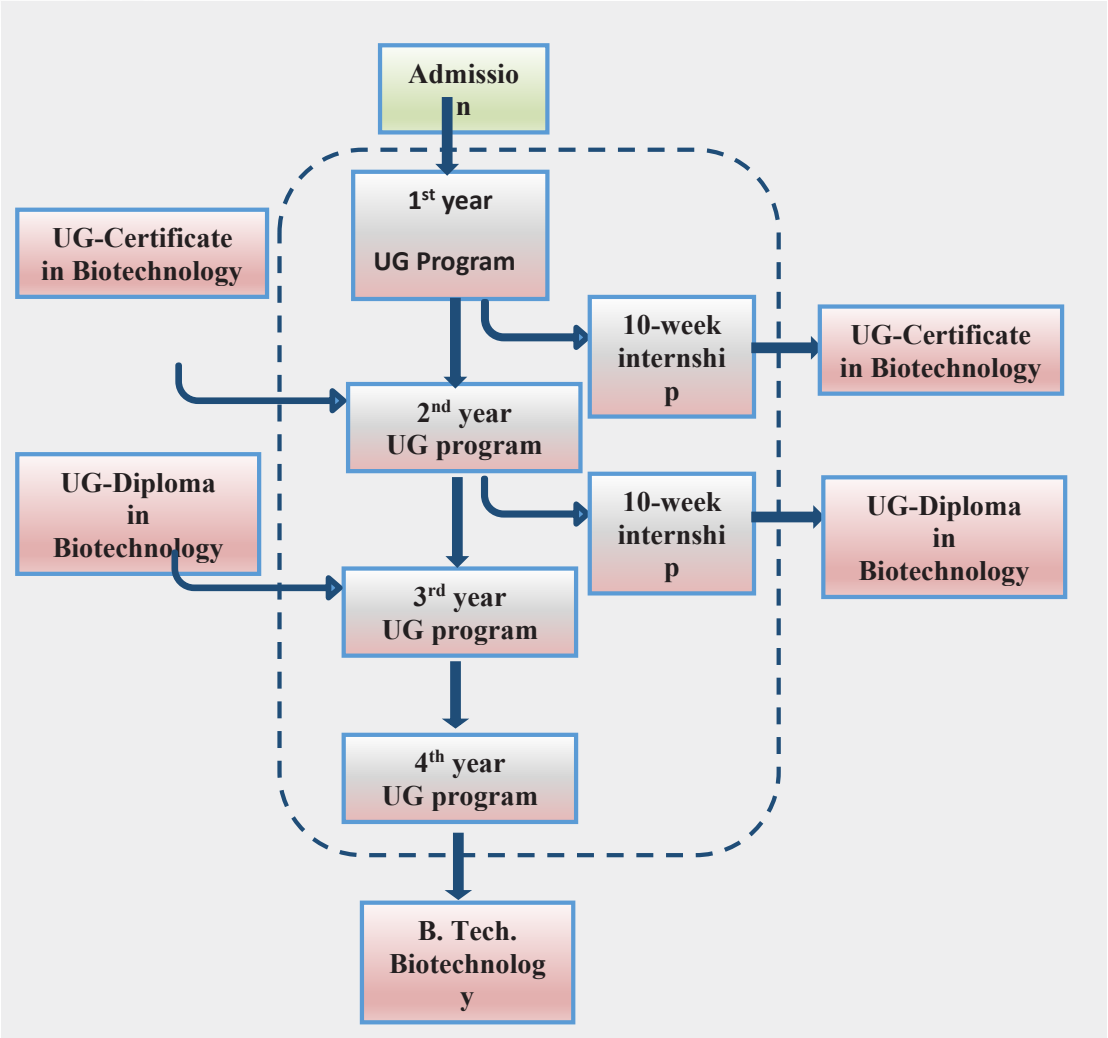

Figure 1. Entry and exit options for the UG program in Biotechnology.

Exit options

1. **UG-Certificate in Biotechnology:** Exit after the first year and completion of a 10-week internship.
2. **UG-Diploma in Biotechnology**: Exit after the second year and completion of a 10-week internship.
3. **B. Tech. Biotechnology:** On successful completion of four-year degree requirements.

Eligibility Criteria: 10+2 or intermediate with Physics, Chemistry, Mathematics, Biology from a recognized Board/University or as per the criteria decided by the ICAR/ SAU.

ACADEMIC PROGRAM
Four-Year B. Tech. Biotechnology
Semester-Wise Course Distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	Semester I		
1.	*Deeksharambh* (Foundation Course)	2 (0+2) NG Non-gradial	
2.	Molecular Biology	3 (3+0)	**21 (14+7) +2 Non-gradial**
3.	Introductory Cell Biology	3 (3+0)	
4.	Fundamentals of Genetics	3 (3+0)	
5.	Basic Mathematics/Basic Botany/Basic Zoology	2 (2+0)	
6.	Farming Based Livelihood Systems	3 (2+1)	
7.	National Cadet Corps I/ National Service Scheme I	1 (0+1)	
8.	Communication Skills	2 (1+1)	
9.	SEC 1: Practices in Plant Tissue Culture/ Practices in Animal Cell Culture	2 (0+2)	
10.	SEC 2: Laboratory Management and Instrumentation	2 (0+2)	
	Semester II		
1.	Introduction to Biotechnology	3 (3+0)	**21 (11+10)**
2.	Introduction to Plant Breeding	3 (2+1)	
3.	Elementary Microbiology	2 (1+1)	
4.	Entrepreneurship Development and Business Management	3 (2+1)	
5.	Environmental Studies and Disaster Management	3 (2+1)	
6.	National Cadet Corps II/ National Service Scheme II	1 (0+1)	
7.	Personality Development	2 (1+1)	
8.	SEC 3: Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)	
9.	SEC 4: Bioinformatics and Biocomputation	2 (0+2)	
	Second Year		
	Semester III		
1.	Livestock Production and Management	3 (2+1)	**20 (12+8)**
2.	Recombinant DNA Technology	2 (2+0)	
3.	Classical and Molecular Cytogenetics	3 (2+1)	
4.	Plant Physiology/Anatomy and Physiology of Livestock	3 (2+1)	
5.	Fundamentals of Crop Protection/ Livestock Product Technology	3 (2+1)	
6.	Biomathematics	2 (2+0)	
7.	Physical Education, First Aid and Yoga Practice	2 (0+2)	
8.	SEC 5: Methods in Recombinant DNA Technology	2 (0+2)	

Semester IV			
1.	Introductory Bioinformatics	4 (3+1)	**21 (15+6)**
2.	Molecular Marker Technology	2 (2+0)	
3.	Biodiversity and Its Conservation	2 (2+0)	
4.	Basic Biochemistry	4 (3+1)	
5.	Human Ethics	1 (1+0)	
6.	Agriculture Marketing and Trade	3 (2+1)	
7.	Agriculture Informatics and Artificial Intelligence	3 (2+1)	
8.	SEC 6: Practices in Molecular Marker Technology	2 (0+2)	
Third Year			
Semester V			
1.	Microbial Genetics	4 (3+1)	**23 (18+5) +2 (Non-gradial)**
2.	Molecular Genetics	3(3+0)	
3.	Nanobiotechnology	4 (3+1)	
4.	Animal Biotechnology	3 (2+1)	
5.	Genomics and Proteomics	3 (3+0)	
6.	Enzymology and Enzyme Technologies	3 (2+1)	
7.	Immunology	3 (2+1)	
8.	Educational Tour	2 (0+2) NG	
Semester VI			
1.	Molecular Diagnostics	3 (2+1)	**20 (15+5)**
2.	Industrial Biotechnology	3 (3+0)	
3.	Epigenetics and Gene Regulation	2 (2+0)	
4.	IPR, Biosafety and Bioethics	2 (2+0)	
5.	Computational Biology	3 (2+1)	
6.	Introduction to Animal Breeding	3 (2+1)	
7.	Biostatistics	2 (1+1)	
8.	Food Science and Processing	3 (2+1)	
Fourth Year			
Semester VII			
	Elective I. Plant Biotechnology		
1.	Applications of Genomics and Proteomics	4 (3+1)	**20 (14+6)**
2.	Principles of Molecular Breeding	4 (3+1)	
3.	Principles and Procedures of Plant Tissue Culture	3 (2+1)	
4.	Molecular Breeding in Field and Horticultural Crops	3 (2+1)	
5.	Seed Biology, Biotechnology, Production and Management	3 (2+1)	
6.	Plant Genetic Transformation	3 (2+1)	

	Elective II. Animal Biotechnology		
1.	Principles and Procedures of Animal Cell Culture	4 (3+1)	**20 (15+5)**
2.	Animal Genomics	4 (3+1)	
3.	Transgenic Animal Production	3 (3+0)	
4.	Molecular Virology and Vaccine Production	3 (2+1)	
5.	Embryo Transfer Technologies	3 (2+1)	
6.	Animal Reproductive Biotechnology	3 (2+1)	
	Elective III. Microbial and Environmental Biotechnology		
1.	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)	**20 (16+4)**
2.	Microbial Biotechnology	4 (3+1)	
3.	Bioprospecting of Genes and Molecules	3 (3+0)	
4.	Molecular Ecology and Evolution	3 (3+0)	
5.	Food Biotechnology	3 (2+1)	
6.	Green Biotechnology	3 (2+1)	
	Elective IV. Bioinformatics		
1.	Programming in Bioinformatics	4 (2+2)	**20 (13+7)**
2.	Bioinformatics Tools and Biological Databases	3 (2+1)	
3.	Structural Bioinformatics	3 (2+1)	
4.	Pharmacogenomics	3 (2+1)	
5.	Metabolomics and Systems Biology	4 (3+1)	
6.	Computational Methods for Data Analysis	3 (2+1)	
Semester VIII			
1.	Student READY (RAWE/industry attachment/experiential learning/hands on training/project work/internship) in the area of Plant Biotechnology, Animal Biotechnology, Microbial and Environmental Biotechnology and Bioinformatics	20 (0+20)	**20 (0+20)**

Department-Wise Course Breakup

Sl. No	Department-wise Courses	Credit Hours
Agriculture Courses		
1.	Farming Based Livelihood Systems	3 (2+1)
2.	Introduction to Plant Breeding	3 (2+1)
3.	Fundamentals of Crop Protection	3 (2+1)
4.	Agriculture Marketing and Trade	3 (2+1)
Animal Science Courses		
1.	Livestock Production and Management	3 (2+1)
2.	Anatomy and Physiology of Livestock	3 (2+1)
3.	Livestock Product Technology	3 (2+1)
4.	Introduction to Animal Breeding	3 (2+1)

Sl. No	Department-wise Courses	Credit Hours
Basic Science Courses		
1.	Plant Physiology	3 (2+1)
2.	Biomathematics	2 (2+0)
3.	Basic Biochemistry	4 (3+1)
4.	Enzymology and Enzyme Technologies	3 (2+1)
5.	Immunology	3 (2+1)
6.	Biostatistics	2 (1+1)
Biotechnology Core Courses		
1.	Molecular Biology	3 (3+0)
2.	Introductory Cell Biology	3 (3+0)
3.	Fundamentals of Genetics	3 (3+0)
4.	Practices in Plant Tissue Culture	2 (0+2)
5.	Practices in Animal cell Culture	2 (0+2)
6.	Laboratory Management and Instrumentation	2 (0+2)
7.	Introduction to Biotechnology	3 (3+0)
8.	Elementary Microbiology	2 (1+1)
9.	Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)
10.	Bioinformatics and Biocomputation	2 (0+2)
11.	Recombinant DNA Technology	2 (2+0)
12.	Classical and Molecular Cytogenetics	3 (2+1)
13.	Methods in Recombinant DNA Technology	2 (0+2)
14.	Introductory Bioinformatics	4 (3+1)
15.	Molecular Marker Technology	2 (2+0)
16.	Biodiversity and Its Conservation	2 (2+0)
17.	Practices in Molecular Marker Technology	2 (0+2)
18.	Microbial Genetics	4 (3+1)
19.	Molecular Genetics	3 (3+0)
20.	Nanobiotechnology	4 (3+1)
21.	Animal Biotechnology	3 (2+1)
22.	Genomics and Proteomics	3 (3+0)
23.	Molecular Diagnostics	3 (2+1)
24.	Industrial Biotechnology	3 (3+0)
25.	Epigenetics and Gene Regulation	2 (2+0)
26.	IPR, Biosafety and Bioethics	2 (2+0)
27.	Applications of Genomics and Proteomics	4 (3+1)
28.	Principles of Molecular Breeding	4 (3+1)
29.	Principles and Procedures of Plant Tissue Culture	3 (2+1)
30.	Molecular Breeding in Field and Horticultural Crops	3 (2+1)
31.	Seed Biology, Biotechnology, Production and Management	3 (2+1)

Sl. No	Department-wise Courses	Credit Hours
32.	Plant Genetic Transformation	3 (2+1)
33.	Principles and Procedures of Animal Cell Culture	4 (3+1)
34.	Animal Genomics	4 (3+1)
35.	Transgenic Animal Production	3 (3+0)
36.	Molecular Virology and Vaccine Production	3 (2+1)
37.	Embryo Transfer Technologies	3 (2+1)
38.	Animal Reproductive Biotechnology	3 (2+1)
39.	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)
40.	Microbial Biotechnology	4 (3+1)
41.	Bioprospecting of Genes and Molecules	3 (3+0)
42.	Molecular Ecology and Evolution	3 (3+0)
43.	Food Biotechnology	3 (2+1)
44.	Green Biotechnology	3 (2+1)
45.	Programming in Bioinformatics	4 (2+2)
46.	Bioinformatics Tools and Biological Databases	3 (2+1)
47.	Structural Bioinformatics	3 (2+1)
48.	Pharmacogenomics	3 (2+1)
49.	Metabolomics and Systems Biology	4 (3+1)
50.	Computational Methods for Data Analysis	3 (2+1)
Deficiency/Remedial Courses		
1.	Basic Mathematics	2 (2+0)
2.	Basic Botany	2 (2+0)
3.	Basic Zoology	2 (2+0)
General Courses		
1.	National Cadet Corps I/ National Service Scheme I	1 (0+1)
2.	Communication Skill	2 (1+1)
3.	Entrepreneurship Development and Business Management	3 (2+1)
4.	Environmental Studies and Disaster Management	3 (2+1)
5.	National Cadet Corps II/ National Service Scheme II	1 (0+1)
6.	Personality Development	2 (1+1)
7.	Physical Education, First Aid and Yoga Practice	2 (0+2)
8.	Human Ethics	1 (1+0)
9.	Agriculture Informatics	3 (2+1)
10.	Computational Biology	3 (2+1)
11.	Food Science and Processing	3 (2+1)
Student READY		**20 (0+20)**
Non-gradial Courses		
1.	*Deeksharambh* (Foundation Course)	2 (0+2)

Sl. No	Department-wise Courses	Credit Hours
2.	Educational Tour	2 (0+2)
MOOCs/Online Courses		**10 (0+10)**

Summary of Credit Hours for Different Categories of Courses

Sl. No.	Major Courses	Credit Hours	Total Credit Hours
1	Molecular Biology	3 (3+0)	
2	Introductory Cell Biology	3 (3+0)	
3	Fundamentals of Genetics	3 (3+0)	
4	Introduction to Biotechnology	3 (3+0)	
5	Introduction to Plant Breeding	3 (2+1)	
6	Elementary Microbiology	2 (1+1)	
7	Livestock Production and Management	3 (2+1)	
8	Recombinant DNA Technology	2 (2+0)	
9	Classical and Molecular Cytogenetics	3 (2+1)	
10	Introductory Bioinformatics	4 (3+1)	
11	Molecular Marker Technology	2 (2+0)	**60 (51+9)**
12	Biodiversity and Its Conservation	2 (2+0)	
13	Microbial Genetics	4 (3+1)	
14	Molecular Genetics	3 (3+0)	
15	Nanobiotechnology	4 (3+1)	
16	Animal Biotechnology	3 (2+1)	
17	Genomics and Proteomics	3 (3+0)	
18	Molecular Diagnostics	3 (2+1)	
19	Industrial Biotechnology	3 (3+0)	
20	Epigenetics and Gene Regulation	2 (2+0)	
21	IPR, Biosafety and Bioethics	2 (2+0)	
Minor Courses			
1	Basic Mathematics/Basic Botany/Basic Zoology	2 (2+0)	
2	Plant Physiology/Anatomy and Physiology of Livestock	3 (2+1)	
3	Fundamentals of Crop Protection/Livestock Product Technology	3 (2+1)	
4	Biomathematics	2 (2+0)	**32 (23+9)**
5	Basic Biochemistry	4 (3+1)	
6	Human Ethics	1 (1+0)	
7	Enzymology and Enzyme Technologies	3 (2+1)	
8	Immunology	3 (2+1)	

9	Computational Biology	3 (2+1)	
10	Introduction to Animal Breeding	3 (2+1)	
11	Biostatistics	2 (1+1)	
12	Food Science and Processing	3 (2+1)	
Multi-Disciplinary Courses			
1	Farming Based Livelihood Systems	3 (2+1)	**9 (6+3)**
2	Entrepreneurship Development and Business Management	3 (2+1)	
3	Agriculture Marketing and Trade	3 (2+1)	
Value Added Courses			
1	Environmental Studies and Disaster Management	3 (2+1)	**6 (4+2)**
2	Agriculture Informatics	3 (2+1)	
Ability Enhancement Courses			
1	National Cadet Corps I/ National Service Scheme I	1 (0+1)	**8 (2+6)**
2	Communication Skill	2 (1+1)	
3	National Cadet Corps II/ National Service Scheme II	1 (0+1)	
4	Personality Development	2 (1+1)	
5	Physical Education, First Aid and Yoga Practice	2 (0+2)	
Skill Enhancement Courses (SEC)			
1	SEC 1: Practices in Plant Tissue Culture/ Practices in Animal Cell Culture	2 (0+2)	**12 (0+12)**
2	SEC 2: Laboratory Management and Instrumentation	2 (0+2)	
3	SEC 3: Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)	
4	SEC 4: Bioinformatics and Biocomputation	2 (0+2)	
5	SEC 5: Practices in Recombinant DNA Technology	2 (0+2)	
6	SEC 6: Practices in Molecular Marker Technology	2 (0+2)	
Elective Courses in Plant Biotechnology			
1	Applications of Genomics and Proteomics	4 (3+1)	**20 (14+6)**
2	Principles of Molecular Breeding	4 (3+1)	
3	Principles and Procedures of Plant Tissue Culture	3 (2+1)	
4	Molecular Breeding in Field and Horticultural Crops	3 (2+1)	
5	Seed Biology, Biotechnology, Production and Management	3 (2+1)	
6	Plant Genetic Transformation	3 (2+1)	
Elective Courses in Animal Biotechnology			
1	Principles and Procedures of Animal Cell Culture	4 (3+1)	**20 (15+5)**
2	Animal Genomics	4 (3+1)	
3	Transgenic Animal Production	3 (3+0)	
4	Molecular Virology and Vaccine Production	3 (2+1)	

5	Embryo Transfer Technologies	3 (2+1)	
6	Animal Reproductive Biotechnology	3 (2+1)	
Elective Courses in Microbial and Environmental Biotechnology			
1	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)	**20 (16+4)**
2	Microbial Biotechnology	4 (3+1)	
3	Bioprospecting of Molecules and Genes	3 (3+0)	
4	Molecular Ecology and Evolution	3 (3+0)	
5	Food Biotechnology	3 (2+1)	
6	Green Biotechnology	3 (2+1)	
Elective Courses in Bioinformatics			
1	Programming in Bioinformatics	4 (2+2)	**20 (13+7)**
2	Bioinformatics Tools and Biological Databases	3 (2+1)	
3	Structural Bioinformatics	3 (2+1)	
4	Pharmacogenomics	3 (2+1)	
5	Metabolomics and Systems Biology	4 (3+1)	
6	Computational Methods for Data Analysis	3 (2+1)	
Student READY			**20**
Non-gradial Courses			
1	Deeksharambh (Foundation Course)	2 (0+2)	**4 (0+4)**
2	Educational Tour	2 (0+2)	
MOOCs/Online Courses			**10**

Abstract of Credit Hour Allocation over the Semesters (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Courses (MDC)	Value Added Courses (VAC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Internship/ Project/ Student READY	Total Credit Hours	Non-gradial	MOOCs/ Online Courses
I	11	$3^{(1)}$		$1^{(2)} + 2^{(3)}$	$4^{(4,5)}$	-	21	$2^{(6)}$	
II	8	$3^{(7)}$	$3^{(8)}$	$1^{(9)} + 2^{(10)}$	$4^{(11,12)}$	-	21	-	
Post-II	-	-	-	-	-	$10^{(13)}$	-	-	
III	16	-	-	$2^{(14)}$	$2^{(15)}$	-	20	-	
IV	13	$3^{(16)}$	$3^{(17)}$	-	$2^{(18)}$	-	21	-	10
Post-IV	-	-	-	-	-	$10^{(19)}$	-	-	
V	23	-	-	-	-	-	23	$2^{(20)}$	
VI	21	-	-	-	-	-	21	-	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**	**10**

Note: The credit hours indicated represent the combined total of theory and practical components.

(1) Farming Based Livelihood Systems
(2) National Cadet Corps I/ National Service Scheme I
(3) Communication Skill
(4) Practices in Plant Tissue Culture/ Practices in Animal Cell Culture
(5) Laboratory Management and Instrumentation
(6) *Deeksharambh* (Foundation Course)
(7) Entrepreneurship Development and Business Management
(8) Environmental Studies and Disaster Management
(9) National Cadet Corps II/ National Service Scheme II
(10) Personality Development
(11) Basic Techniques of Molecular Biology and Biotechnology
(12) Bioinformatics and Biocomputation
(13) Internship for those exiting with UG-Certificate in Biotechnology
(14) Physical Education, First Aid and Yoga Practice
(15) Practices in Recombinant DNA Technology
(16) Agriculture Marketing and Trade
(17) Agriculture Informatics
(18) Practices in Molecular Marker Technology
(19) Internship for those exiting with UG-Diploma in Biotechnology
(20) Educational Tour

Summary of Credit Distributions

Categories of Courses		Credit Hours
Core Courses (Major and Minor)	:	92
Common Courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Elective Courses	:	20
Student READY	:	20
MOOCs/Online Courses (Non-gradial)	:	10**
Grand Total	**:**	**167+10****

DETAILED SYLLABI

Semester I

Deeksharambh (Foundation Course) 2 (0+2)

Objective

- Aims at creating a platform for students to help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instill life and social skills, social awareness, ethics and values, team work, leadership, creativity, etc. and identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in University, as well as interactions with academic and research managers of the University.

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences.

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences.

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/ establishments.

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.

Molecular Biology **3 (3+0)**

Objectives

1. To study the principles and techniques of molecular biology
2. To study the central dogma of life
3. To study the tools in molecular biology

Theory

History of molecular biology. Central dogma of life. Structure of DNA and RNA. Gene structure and function. DNA replication and transcription. Genetic code and translation. Structure of prokaryotic and eukaryotic nuclear and organelle genomes. Gene regulation in prokaryotes. Lac operon concept and tryp operon concept.

Introduction to microbial genetics; conjugation, transformation and transduction. Tools in molecular biology. Role of enzymes in molecular biology. Principles of Polymerase Chain Reaction and electrophoresis.

Suggested Reading

1. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer Associates Inc, 8th edn.

2. Lewin B, 2017, Gene XII, Oxford University Press.

3. Nelson DL and Cox MM, 2017, Lehninger Principles of Biochemistry. 7th edn. W. H. Freeman.

4. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

Introductory Cell Biology **3 (3+0)**

Objectives

Students will understand-

1. the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles

2. how these cellular components are used to generate and utilize energy in cells
3. the cellular components underlying mitotic cell division
4. apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Theory

Origin and evolution of cell. Introduction to microscopy. Sub-cellular structure of prokaryotic and eukaryotic cells. Membrane structure and function: plasma membrane, cell wall and extracellular matrix. Structural organization and function of intracellular organelles and organelle biogenesis. Nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes, plastids and vacuoles.

Structure and function of the cytoskeleton and its role in motility. Cell membrane transport. Introduction to cell signalling. Cell growth, cell cycle and its control. Cell death and cell renewal.

Suggested Reading

1. Verma PS and Agarwal VK, 2016, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S Chand and Sons.
2. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer Associates Inc.

Fundamentals of Genetics **3 (3+0)**

Objectives

1. To study the history of genetics
2. To study inheritance and variation
3. To study chromosomes and cell division
4. To study the genetic basis of traits

Theory

History of Genetics. Mendel's principles and rediscovery. Cell division. Chromosome structure and function. Chromosome theory of inheritance. Sex-linked, sex-limited and sex-influenced inheritance. Sex determination and sex differentiation.

Multiple allelism. Linkage and crossing-over. Gene-gene interaction. Genetic analysis in prokaryotes and eukaryotes. Extra chromosomal inheritance. Mutations. Hardy-Weinberg law. Quantitative inheritance. Introduction to human genetics. Genetic basis of evolution.

Suggested Reading

1. Brah GS, 2014, Animal Genetics: Concepts and Implications, 2nd edn, Kalyani Publishers.
2. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics. John Wiley and Sons, Inc, New York, USA.

Basic Mathematics 2 (2+0)

Objectives

1. To study the basic principles and functions in mathematics like limits and continuity
2. To study differentiation and integration
3. To study matrices and determinants

Theory

Functions; Limit: Introduction, left-handed and right-handed limits, general rules for the calculation of limits Standard limits. Continuity: Definition of continuity, continuity of algebraic functions. Continuity of trigonometric and exponential functions.

Differentiation: Differentiation by the first principle, sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, geometrical interpretation of derivative, maxima and minima, tangent and normal.

Integration: Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix. Solution of linear equations; by Crammer's rule and inverse of matrix.

Suggested Reading

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

Basic Botany 2 (2+0)

Objectives

1. To study the basic taxonomy and classification of plants
2. To study the features of plant kingdom and morphology
3. To study the internal structure of plants

Theory

Plant kingdom and features of each group. Morphology, modifications and functions of root, stem, leaf, flower and inflorescence. Pollination and fertilization. Fruit types. Structure of dicot and monocot seed, and seed germination.

Cell structure. DNA, chromosome and genes. Cell and tissue types. Internal structure of root, stem and leaf.

Plant taxonomy, systems of classification. Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Suggested Reading

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th edn, Rastogi Publications.

2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi publications.
3. Bhatia K.N. and Tyagi M.P. 2020 Elementary Biology. A truemen publication
4. David M Hillis; H Craig Heller; Sally D Hacker; David W Hall; David E Sadava. 2020. Life: the science of biology 12th edn, Sunderland publication. eBook
5. Dutta AC, 1995, A Class Book of Botany, 16th edn, Oxford University Press.
6. NCERT 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A textbook of Botany Angiosperm. S. Chand publications.

Basic Zoology 2 (2+0)

Objectives

1. To study cells and biomolecules
2. To study animal kingdom and nomenclature
3. To study the organization of mammalian systems

Theory

Introduction to Zoology. Structure and functions of cell and cell organelles. Difference between prokaryotic and eukaryotic cell. Structure and function of biomolecules. Types of simple and compound tissues.

Binomial nomenclature. Classification and general survey of the animal kingdom. Functional organization of various systems of a mammal; digestive, circulatory, respiratory, excretory, nervous and reproductive. Laws of inheritance. Multipleallelism - blood groups. Genetic disorders in human and their inheritance.

Suggested Reading

1. Bhatia KN and Tyagi MP, 2020, Elementary Biology, A Truemen Publication.
2. Chopra G and Dhami PS, 2021, A Text Book of Biology, Pradeep Publications.
3. David MH, Craig HH, Sally DH, David WH and David ES, 2020, Life: the science of biology, 12th Ed, Sunderland Publication.
4. NCERT, 2022, Biology of Class XI, 2022-23. NCERT, India.

Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states. Income of farmers and rural people in India. Livelihood-definition, concept and livelihood pattern in urban and rural areas. Different indicators to study livelihood systems. Agricultural livelihood systems (ALS); meaning, approach, approaches and framework. Definition of farming systems and farming based livelihood systems prevalent farming systems in India contributing to livelihood. Types of traditional and modern farming

systems. Components of farming system/ farming-based livelihood systems- crops and cropping systems, livestock, (dairy, piggery, goatry, poultry, duckry etc.). Horticultural crops, agroforestry systems, aquaculture, duck/poultry cum fish, dairy cum fish, piggery cum fish etc. Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers. Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones. Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country. Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems. Schemes and program by central and state government, public and private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises. Study of components of important farming-based livelihood models/ systems in different agro-climatic zones. Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models. Field visit of innovative farming system models. Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and study of agri-enterprises involved in industry and service sectors (value chain models). Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis. Case study of start-ups in agri-sectors.

Suggested Reading

1. Agarwal A and Narain S, 1989, Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi.
2. Ashley C and Carney D, 1999, Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7.
3. Bhatt BP, Abhay Kumar, Thakur PK, RS, Amitava Dey UK, Sanjeev Kumar BK, Jha, LK, Pathak KN, Hassan A, Singh SK, Singh KK and Singh KM, 2014, Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar.
4. Carloni A, 2001, Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.
5. Dixon J, Gulliver A and Gibbon D, 2001, Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World, FAO & World Bank, Rome, Italy & Washington, DC, USA.
6. Evenson RE, 2000, Agricultural Productivity and Production in Developing Countries', In FAO, The State of Food and Agriculture, FAO, Rome, Italy.
7. Panwar AS, Ravisankar N, Prusty AK, Shamim M, Singh R, Bhaskar S, Malik SK, Tomar RK, Arunachalam A and Alagusundaram K, 2019, Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.

8. Reddy SR, 2016, Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh JP, Ravisankar N, Prusty AK, Sikka AK and Gangwar B, 2016, Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series 1). IIFSR Bulletin No. 2016-1, AICRP on Integrated Farming Systems, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, pp. 1-88.
10. Walia SS and Walia US, 2020, Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

National Cadet Corps I(0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical

Aims, objectives, organization of National Cadet Corps (NCC) and NCC song. DG's cardinals of discipline. Drill- aim, general words of command, attention, stands at ease, stand easy and turning. Sizing, numbering, forming in three ranks, open and close order march, and dressing. Saluting at the halt, getting on parade, dismissing, and falling out. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. Marking time, forward march, and halt. Changing step, formation of squad and squad drill. Command and control, organization, badges of rank, honours, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme-I 1 (0+1)

Objective

- Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical

Orientation: history, objectives, principles, symbol, badge; regular programs under National Service Scheme (NSS). Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health. NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change. Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace- building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism. Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication process: the magic of effective communication. Building self-esteem and overcoming fears. Concept, nature and significance of communication process. Meaning, types and models of communication. Verbal and non-verbal communication. Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic communication skills. Listening, speaking, reading and writing skills. Precise writing/ abstracting/summarizing. Style of technical communication. Curriculum vitae/resume writing. Innovative methods to enhance vocabulary, analogy questions.

Structural and functional grammar. Sentence structure, modifiers, connecting words and verbal. Phrases and clauses. Case: subjective case, possessive case, objective case. Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles. Agreement of verb with the subject: tense, mood, voice. Writing effective sentences. Basic sentence faults.

Practical

Listening and note taking. Writing skills; precise writing, summarizing and abstracting. Reading and comprehension (written and oral) of general and technical articles. Micro-presentations and impromptu presentations. Feedback on presentations. Stage manners; grooming, body language, voice modulation, speed. Group discussions. Public speaking exercises; vocabulary building exercises. Interview techniques. Organization of events.

Suggested Reading

1. Allport, GW, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown M and Gyles B, 1994, How to Interview and be Interviewed, Sheldon Press, London.
3. Carnegie D, 1997, The Quick and Easy Way to Effective Speaking, Pocket Books, New York.
4. Francis Peter SJ, 2012, Soft Skills and Professional Communication, Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills, Oxford University Press.
6. Neuliep JW, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, A, 1998, Body Language, Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication, Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking, Oxford University Press.
10. Thomson AJ and Martinet AV, 1977, A Practical English Grammar, Oxford University.

Practices in Plant Tissue Culture 2 (0+2)

Objectives

This course aims at

1. Imparting hands-on training on the calculation of per cent solutions, molarity, molality, normality; and preparation of buffers
2. Studying basic equipments used in plant molecular biology and cell culture laboratories; washing, packing and sterilization of glass and plastic wares for cell culture
3. Studying preparation of media and reagents for cell culture, primary culture technique, culture and sub-culturing of continuous cell lines, viability assay by trypan blue dye exclusion method, micropropagation, haploid production, embryo rescue, cryopreservation of primary cultures and cell lines
4. Studying preparation of phytohormones and sterilization
5. Studying tissue culture laboratory management

Practical

Laboratory safety and aseptic techniques, sterilization methods for equipment and media, media preparation, preparation of solid and liquid media, pH adjustment and sterilization of media. Culture initiation and explant selection. Selection of explants: meristem, node, leaf, embryo etc. Surface sterilization of plant material. Techniques for explant preparation and inoculation on to culture media. Callus induction and subculture. Subculture techniques: transfer of cultures to fresh media, monitoring and maintenance of cultures, organogenesis and embryogenesis. Micropropagation. Genetic transformation. Cryopreservation and conservation. Project Work: students design and conduct a small-scale tissue culture project. They will choose a plant species, select appropriate explants, culture them in vitro, and document the progress and results.

Suggested Reading

1. Bhojwani SS and Razdan MK, 1996, Plant Tissue Culture: Theory and Practice, Elsevier.

2. Reinert J and Bajaj YPS (Ed), 1989, Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Springer-Verlag.

Practices in Animal Cell Culture 2 (0+2)

Objectives

To learn-

1. Washing of glasswares, packing and sterilization of glass and plasticware for cell culture
2. Preparation of media and reagents for cell culture.
3. Primary culture technique. Culture and sub-culturing of continuous cell lines. Viability assay by trypan blue dye exclusion method. Cryopreservation of primary cultures and cell lines.
4. Tissue culture laboratory management.

Practical

Laboratory safety and aseptic techniques. Cell culture media and supplements. Composition of cell culture media: DMEM, RPMI, MEM, etc. Serum and serum-free media formulations. Preparation and sterilization of media supplements. Cell culture initiation and maintenance. Cell line authentication and characterization, Thawing and subculturing of cells. Monitoring cell growth and viability. Cell passaging and cryopreservation. Cell line development and authentication. Methods for establishing new cell lines. Authentication techniques: STR profiling, isoenzyme analysis, quality control measures in cell culture. Cell-based assays. Principles of cell-based assays: viability, proliferation, apoptosis, techniques for measuring cell responses: MTT assay, flow cytometry, ELISA. Application of cell-based assays in drug screening and toxicity testing. Transfection (lipofection, electroporation) and gene expression, 3D-cell culture and tissue engineering, cell culture project. Students design and conduct a small-scale cell culture project. They will choose a specific cell line or assay, culture cells accordingly, perform experiments, analyze data, and present their findings.

Suggested Reading

1. Al-Rubeai M (Ed), 2015, Animal cell culture. Springer International Publishing, ISBN: 978-3-319-10319-8, 978-3-319-10320-4.
2. Bhatia S, Naved T and Sardana S, 2019, Introduction to animal tissue culture science, IOP Publishing Ltd.
3. Butler M, 2004, Animal cell culture and technology, Taylor and Francis, ISBN: 9781859960493,1859960499.
4. Davis JM (Ed), 2011, Animal cell culture: essential methods. John Wiley and Sons, ISBN: 0470666587, 9780470666586.
5. Michael B, 2003, Animal Cell Culture and Technology, THE BASICS (Garland Science).

Laboratory Management and Instrumentation 2 (0+2)

Objectives

1. To study the establishment and management of different molecular biology laboratories
2. To impart hands-on training on good laboratory practices, calculation of per cent solutions, molarity, molality, normality; and preparation of buffers

3. To study basic equipments used in animal molecular biology and cell culture laboratories, record keeping, teamwork, and SOP of different instruments of the labs
4. Safe disposal of laboratory chemiclas and reagents as per the biosafety guidelines.

Practical

Importance of laboratory safety and regulatory compliance. Quality management systems: ISO 9001, GLP, GMP, laboratory safety and regulatory compliance. Risk assessment and hazard identification. Inventory management and equipment maintenance. Principles of laboratory inventory management. Equipment calibration and preventive maintenance. Documentation and record-keeping for regulatory compliance. Quality assurance and control. Introduction to quality assurance (QA) and quality control (QC). Quality control checks for laboratory reagents and instruments, Troubleshooting common laboratory errors and deviations. Spectroscopy and spectrophotometry, applications in quantitative analysis and molecular biology. Chromatography techniques, microscopy and imaging. Molecular biology techniques. Instrumentation project: students design and conduct a small-scale project using one of the laboratory instruments covered in the course. They will collect data, analyze results, and present their findings.

Suggested Readings

1. Fulekar MH and Pandey B, 2013, Bioinstrumentation, ISBN: 9789382332398.
2. Gakhar SK, Miglani M and Ashwani K, 2013, Molecular Biology: A Laboratory Manual, ISBN: 9789382332305.
3. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual 4th edn, Cold Spring Harbor.
4. Kreuzer H and Massey A, 2008, Molecular biology and biotechnology: a guide for students 3rd edn, ASM Press.
5. Rapley R and Whitehouse D, (Eds), 2015, Molecular biology and biotechnology, Royal Society of Chemistry.

Semester II

Introduction to Biotechnology 3 (3+0)

Objectives

1. To understand the basic concepts of molecular biology and methods used in the manipulation of nucleic acids to isolate and characterize genes
2. To understand how molecular tools are used to modify an organism. To study the history, concepts and scope of biotechnology
3. To study the applications of biotechnology

Theory

Introduction to genetic material, history of genetic material, physical and chemical basis of genetic material. Structure of DNA and RNA, scope and importance of Biotechnology. Plant, microbial, animal, medical, environmental, industrial. Marine, agricultural and food biotechnology. Nanobiotechnology.

Introduction to recombinant DNA technology. Vectors, DNA manipulating and modifying enzymes, gene cloning. Introduction to genomics and proteomics. Molecular markers, DNA sequencing. Genetic transformation and transgenic organisms. Bioinformatics. Biosafety guidelines.

Suggested Readings

1. Chawla HS, 2024, Introduction to Plant Biotechnology, 4th edn, CBS Publishers and Distributors Pvt. Ltd.
2. Singh B, Gautam SK, Chauhan MS and Singla SK, 2015, Textbook of Animal Biotechnology, The Energy and Resources Institute, TERI.
3. Singh BD, 2020, Biotechnology Expanding Horizons, Kalyani publishers.
4. Thieman W and Palladino M, 2018, Introduction to Biotechnology (What's New in Biology), 4th edn, Pearson ISBN 0134650190, 9780134650197

Introduction to Plant Breeding 3 (2+1)

Objectives

To study the-

1. development and goals of plant breeding
2. modes of reproduction
3. methods of plant breeding

Theory

History, aims and objectives of plant breeding. Role of related sciences in plant breeding. Modes of reproduction - sexual, asexual, apomixes and significance in plant breeding. Modes of pollination, genetic consequences, differences between self- and cross-pollinated crops. Germplasm resources and their utilization.

Methods of breeding: introduction and acclimatization. Selection: mass selection, Johannesen's pureline theory, genetic basis, pure-line selection. Hybridization: aims and objectives, types of hybridization. Methods of handling segregating generations. Pedigree method, bulk method, back cross method. Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigour. Hardy Weinberg law, selection in cross-pollinated crops. Population improvement program. Synthetics and composites. Methods of breeding vegetatively propagated crops.

Incompatibility and male sterility and their utilization in crop improvement. Mutation breeding. Ploidy breeding. Wide hybridization and its significance in crop improvement. Procedure for release of new varieties.

Practical

Classification of plants. Botanical description and floral biology of field crops: rice, sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, red gram, bengal gram, green gram, soybean, black gram, cotton. Study of megasporogenesis and microsporogenesis. Fertilization and life cycle of an angiosperm plant. Hybridization techniques and precautions to be taken. Selfing, emasculation and crossing techniques. Study of male sterility and incompatibility.

Suggested Reading

1. Allard RW. 1960. Principles of Plant Breeding, John Wiley and Sons.
2. Chahal GS and Gosal SS, 2002, Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches, Narosa Publishers.
3. Singh P, 2014, Essentials of Plant Breeding, Kalyani Publishers.
4. Singh BD, 2009, Plant Breeding: Principles and Methods, Kalyani Publishers.

Elementary Microbiology 2 (1+1)

Objectives

To study the-

1. History of microbiology and major groups of eukaryotes and prokaryotes
2. Preservation methods and repositories
3. Bacterial growth and metabolism
4. Applications of microbes

Theory

History of microbiology and its applied areas. Microorganisms and their role in health and environment. Control and prevention measures against microorganisms/diseases. Introduction to eukaryotic and prokaryotic cells. Major groups of eukaryotes; fungi, algae and protozoa. Major groups of prokaryotes; bacteria, archaebacteria, rickettsia and chlamydia. Preservation of microorganisms, microbial repositories at national and international level.

Bacterial growth. Metabolism in bacteria, ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation. Viruses and Bacteriophages, structure and properties, lytic and lysogenic cycles, viroids, prions.

Beneficial microorganisms in agriculture, biofertilizers, microbial pesticides. Microbes in composting and biodegradation. Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory. Media preparation, sterilization and aseptic methods for isolation, identification, preservation and storage. Identification of bacteria by staining methods. Enumeration of bacteria by pour plate and spread plate methods. Micrometery.

Suggested Reading

1. Woolverton CJ, Sherwood LM, and Willey JM, 2016, Presscotts Microbiology, McGraw-Hill Education.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Reading

1. Charantimath PM, 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V, 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Gupta CB, 2001, Management Theory and Practice. Sultan Chand & Sons.
4. Grover I, 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka SS, 1999, Entrepreneurial Development. S. Chand & Co.
6. Mehra P, 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey M and Tewari D, 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D, 1995, Effective Managerial Leadership. Deep & Deep Publications.
9. Singhal RK, 2013, Entrepreneurship Development & Management, Katson Books.
10. Tripathi PC and Reddy PN, 1991, Principles of Management. Tata McGraw Hill.
11. Desai V, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publication House.

Environmental Studies and Disaster Management 3 (2+1)

Objective

- To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to environment; environmental studies. Definition, scope and importance, multidisciplinary nature of environmental studies. Segments of environment, spheres of earth; lithosphere, hydrosphere, atmosphere. Different layers of atmosphere. Natural resources; classification. Forest resources. Water resources. Mineral resources. Food resources. Energy resources. Land resources. Soil resources. Ecosystems. Concept of an ecosystem; structure and function of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and value of biodiversity. Biodiversity hot spots. Threats and conservation of biodiversity.

Environmental pollution. Definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, light pollution. Solid waste management; classification of solid wastes and management methods, composting, incineration, pyrolysis, biogas production, causes, effects and control measures of urban and industrial wastes. Social issues and the environment. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics; issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection act. Air (prevention and control of pollution) act. Water (prevention and control of pollution) act. Wildlife Protection Act. Forest Conservation act. Human population and the environment; environment and human health. Human rights, value education. Women and child welfare. Role of information technology in environment and human health.

Disaster management; disaster definition, types, natural disasters, floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made disasters, nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and national strategy for disaster reduction. Concept of disaster management, national disaster management framework, financial arrangements, role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control. Armed forces in disaster response. Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy; biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site urban/rural/industrial/agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis; pH, EC and TDS. Estimation of Acidity, alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of suspended particulate matter (SPM). Study of simple ecosystem, visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Reading

1. Barucha E, 2004, Text book for Environmental studies, University Grants Commission, NewDelhi.
2. De AK, 2010, Environmental chemistry, New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
3. Dhar Chakrabarti PG, 2011, Disaster management - India's risk management policy frameworks and key challenges. Centre for Social Markets (India), Bangalore. 36 pp.
4. Parthiban KT, Vennila S, Prasanthrajan M, Umesh Kanna S, 2023, Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi.
5. Prasanthrajan M, and Mahendran PP, 2008. A text book on Ecology and Environmental Science, ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur.
6. Prasanthrajan M, 2018, Objective environmental studies and disaster management, ISBN 9789387893825, Scientific publishers, Jodhpur.
7. Sharma PD, 2009, Ecology and Environment, Rastogi Publications, Meerut. -----Tyler M and Scot S, 2009, Living in the Environment (Concepts, Connections, and Solutions), Cengage Learning Publication, Belmont, USA.

National Cadet Corps (NCC- II) 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honour, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1 (0+1)

Objectives

- To evoke social consciousness among students through various activities, viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs. Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations. Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Personality Development 2 (1+1)

Objectives

- To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, nature of personality, theories of personality and its types. The humanistic approach, Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs typology indicator. Locus of control and performance. Type A and Type B behaviours, personality and organizational behaviour.

Foundations of individual behaviour and factors influencing individual behaviour. Models of individual behaviour. Perception and attributes and factors affecting perception. Attribution theory and case studies on perception and attribution. Learning; meaning and definition, theories and principles of learning. Learning and organizational behaviour. Learning and training, learning feedback. Attitude and values. Intelligence; types of intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and organizational behaviour, emotional intelligence. Motivation; theories and principles. Teamwork and group dynamics.

Practical

MBTI personality analysis. Learning styles and strategies. Motivational needs. Firo-B, Interpersonal Communication. Teamwork and team building. Group Dynamics. Win-win game. Conflict Management. Leadership styles. Case studies on Personality and Organizational Behaviour.

Suggested Reading

1. Andrews S, 1988, How to Succeed at Interviews, 21st (reprint), Tata McGraw-Hill, New Delhi.
2. Heller R, 2002, Effective Leadership, Essential Manager series, DK Publishing.
3. Hindle T, 2003, Reducing Stress, Essential Manager series, DK Publishing.
4. Lucas S, 2001, Art of Public Speaking, Tata McGraw-Hill, New Delhi.
5. Mile DJ, 2004, Power of Positive Thinking, Rohan Book Company, New Delhi.
6. Pravesh Kumar, 2005, All about Self- Motivation, Goodwill Publishing House, New Delhi.
7. Smith B, 2004, Body Language, Rohan Book Company, New Delhi.
8. Shaffer DR, 2009, Social and Personality Development, 6th edn, Wadswor, Belmont, CA.

Basic Techniques of Molecular Biology and Biotechnology 2 (0+2)

Objectives

1. To provide hands-on training on isolation and purification of DNA. Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis. Designing of PCR primers, DNA amplification using PCR, elution of PCR products, SDS PAGE, staining and de-staining of proteins, Western blot.
2. To study bacteriological media, preparation of media for bacterial culture, preparation of competent cells and transformation, isolation of plasmids from bacteria, and preservation of bacterial clones.
3. To study basic computing. Introduction to UNIX, LINUX. Nucleotide information resource: EMBL, GenBank, DDBJ, unigene, protein information resource: SwissProt, TrEMBL, Uniprot; structure databases: PDB, MMDB. Search engines: Entrez, ARSA, SRS. Similarity searching: BLAST and interpreting results. Multiple sequence alignment: ClustalW; structure visualization of DNA and proteins using Rasmol.

Practical

Overview of molecular biology: DNA, RNA, proteins. Laboratory safety and basic techniques. Nucleic acid extraction. Principles of DNA and RNA extraction from various sources. Extraction methods: Phenol-chloroform, silica-based columns, quality assessment and quantification of nucleic acids. Polymerase Chain Reaction (PCR), Optimization of PCR conditions and troubleshooting, gel electrophoresis, analysis of PCR products, restriction digests, and DNA/RNA samples. Molecular cloning, DNA sequencing. Principles of DNA sequencing: Sanger sequencing, DNA sequencing reaction setup and analysis, interpretation of sequencing data and sequence alignment. Protein analysis techniques. Gene expression analysis. Practical project: students design and conduct a small-scale molecular biology project. They will choose a specific technique or experiment, perform the necessary procedures, analyze data, and present their findings.

Suggested Reading

1. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual, 4th edn, Cold Spring Harbor.
2. Kreuzer H and Massey A, 2008, Molecular biology and biotechnology: a guide for students, 3rd edn, ASM Press.

3. Rapley R and Whitehouse D, (Eds), 2015, Molecular biology and biotechnology, Royal Society of Chemistry.

Bioinformatics and Biocomputation 2 (0+2)

Objectives

1. To expose the students to the construction and use of computers, special algorithms, new complexity theories, computing science and related mathematics
2. To understand the scientific and economic impact of bioinformatics
3. To have a better understanding of organisms, their metabolism and their evolution
4. To study their applications in health care and drug design, new (bio)materials and their engineering, food (engineering) and food production

Practical

Information search and data retrieval, genome analysis and gene mapping, alignment of pairs of sequences, alignment of multiple sequences and phylogenetic analysis, tools for similarity search and sequence alignment, profiles and hidden Markov models, gene identification and prediction, gene expression analyses, protein classification and structure analysis and visualization, protein structure prediction, computational methods for pathway and systems biology, technologies and strategies for drug discovery, biomarkers in drug development, computer-aided drug design.

Suggested Reading

1. Altman RB, Dunker AK, Hunter L, Ritchie MD, Murray TA and Klein TE, 2017, Biocomputing, https://doi.org/10.1142/10388.
2. Laplante PA (Ed), 2004, Biocomputing, ova Biomedical.

Semester III

Livestock Production and Management 3 (2+1)

Objectives

To study the-

1. history of livestock in India, animal husbandry and breeds of livestock
2. management of livestock in terms of the housing system, health, and diseases
3. economic importance of livestock

Theory

Livestock history in India: Vedic, medieval and modern era. Demographic distribution of livestock and role in economy. Introductory animal husbandry. Breeds of livestock, cattle, buffalo, sheep, goat and pig. Important traits of livestock. General management and feeding practices of animals. Handling and restraining of animals. Housing systems. Importance of grasslands and fodders in livestock production. Common farm management practices including disinfection, isolation, quarantine and disposal of carcass. Common vices of animals and their prevention. Diseases and parasite control and hygiene care.

History and economic importance of poultry. Poultry breeds. Reproductive system of male and female birds. Formation and structure of eggs. Important economic traits of poultry. Egg production, egg weight, egg quality. Fertility and hatchability, plumage characteristics and comb types. Care and management of chicks, grower and layers/broiler. Brooding management. Hatchery practices. Poultry Diseases, control and hygiene care.

Practical

Visit to livestock farms/demonstration centres. Breeds of cattle, buffalo, sheep, goat and pigs. Familiarization with body parts of animals. Handling and restraining of cattle, buffalo, sheep, goat and swine. Male and female reproductive system and artificial Insemination. Feeding of livestock. Methods of identification: marking, tattooing, branding, tagging. Milking methods. Record Keeping. Visit to the poultry farm, poultry breeds, body parts of chicken, duck, quail and turkey. Housing, equipment, nesting and brooding requirements. Male and female reproductive system. Methods of identification and sexing. Hatchery layout and equipment. Identification of diseases and control of parasites. Vaccination and maintenance of farm records.

Suggested Reading

1. Banerjee GC, 2020, A Textbook of Animal Husbandry, Oxford and IBH Publication.
2. Sastry NSR and Thomas CK, 2020, Dairy Bovine Production, Kalyani Publishers.
3. Thomas CK and Sastry NSR, 2020, Livestock Production Management, Kalyani Publishers.

Recombinant DNA Technology 2 (2+0)

Objectives

1. The students will be trained on the principles of genetic engineering
2. To study the components like vectors, enzymes, and host cells
3. To study methods used for confirming cloning and expression

Theory

Recombinant DNA technology. Restriction endonucleases: types and uses. DNA manipulating enzymes, DNA ligases. Vectors: properties of an ideal vector, structure of vector, cloning vectors and expression vectors; plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, shuttle vectors, co-integrating vectors. Competent cells. Gene isolation and cloning; Genetic transformation of *E. coli*, gel electrophoresis, preparation of probes, Southern blotting; Northern blotting; Western blotting, PCR and PCR based methods in recombinant DNA technology.

Suggested Reading

1. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

Classical and Molecular Cytogenetics 3 (2+1)

Objectives

This course aims at studying the-

1. basics of chromatin

2. chromosome, banding and chromosome variations
3. genome analysis through chromosome variations

Theory

Introduction and history. Structure of chromatin. Chromosome structure and chromosome landmarks. Specialized chromosomes. Differential staining of the chromosomes - Q-banding, G banding, C banding, R banding. In situ hybridization-FISH, GISH.

Changes in chromosome number: aneuploidy - monosomy, trisomy and tetrasomy, haploidy and polyploidy- autopolyploidy and allopolyploidy. Methods of doubled haploid production. Structural aberrations of chromosomes: deletions, duplications, inversions and translocations. Locating genes on chromosomes. Genome analysis.

Practical

Lymphocyte culture from blood for karyotyping. Fibroblast cultures from eggs for karyotyping. Preparation of metaphase chromosome spread. Staining techniques of chromosome spreads. Karyotyping and ideogram preparation, chromosome banding techniques: Q-banding, G banding, C banding, R banding

Suggested Reading

1. Becker K and Hardin, 2004, The World of Cell. 5th edn, Pearson Edu.
2. Carroll M, 1989, Organelles, The Guilford Press.
3. Charles B, 1993, Discussions in Ccytogenetics, Prentice Hall.
7. Fan YS, 2002, Molecular Cytogenetics: Protocols and Aapplications. Humana Press.
4. Gupta PK, 2007, Cytogenetics, Rastogi publications.
6. Mahabal R, 2010, Fundamentals of Cytogenetics and Genetics, PHI Learning Pvt. Ltd.
5. Popescu P, Hayes H and Dutrillaux B, 2000, Techniques in Aanimal Ccytogenetics, Springer Science and Business Media.

Plant Physiology 3 (2+1)

Objectives

1. This course aims at introducing concepts of plant physiology and their importance in agriculture
2. To study the plant growth and metabolism
3. To study plant's response to stresses

Theory

Plant physiology, its scope in agriculture. Osmosis, imbibition, water absorption, water translocation and transpiration. Stomatal mechanisms. Physiological role and deficiency symptoms of major and minor elements. Absorption and translocation of minerals.

Concepts of photosynthesis, photorespiration, respiration and translocation of photoassimilates. Dynamics of growth. Stress physiology. Nitrogen and sulphur metabolism. Plant growth regulators.

Their biosynthesis and physiological roles, seed germination and seed dormancy, senescence, vernalization.

Practical

Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis. Ascent of sap, transpiration. Deficiency symptoms of nutrients in crop plants. Plant growth analysis. Quantitative and qualitative estimation of plant pigments. Experiments on photosynthesis and respiration. Effects of plant growth regulators on plant growth and seed germination. Experiments on seed dormancy. Relative water content and plant water potential. Proline estimation.

Suggested Reading

1. Bhatia KN and Prashar AN, 1990, Plant Physiology, Trueman Book Company.
2. Salisbury FB and Ross CW, 1992, Plant Physiology, Wordsworth Publishing Company.
3. Srivastava HN, 2000, Plant Physiology, Pradeep Publications.
4. Taiz L and Zeiger E, 2002, Plant Physiology, Sinauer Associates; 3 Edition.

Anatomy and Physiology of Livestock 3 (2+1)

Objectives

1. This course introduces the basic concepts in the anatomy and physiology of livestock
2. To study the structure and function of various tissues and organs
3. To study the physiological aspects of tissues and organs

Theory

Definition of terms used in veterinary anatomy, topography, contour, landmarks and functional anatomy of various organs in cow, buffalo, sheep and goat structural and functional classification of muscles.

Structure of animal cells and tissues: study of microscopic structure of organs from digestive, urinary, respiratory, reproductive, nervous, cardiovascular and endocrine systems. Gametogenesis, fertilization, cleavage, gastrulation and the development of fetal membranes in livestock, structure and types of mammalian placenta. Development of the organs of digestive, urogenital, cardiovascular, nervous and endocrine glands.

Introduction to blood physiology. Genetic and endocrine control of the reproductive system; maternal recognition of pregnancy. Introduction to physiology of mammary glands: structure and development, hormonal control of mammary growth, lactogenesis and lactation cycle.

Practical

Hands-on training on the structure and function of the major body systems in livestock, including mammals such as cattle, sheep, goats, and pigs. Practical applications in livestock management and health.

Suggested Reading

1. Dyce KM, Sack MO and Wensing CJS, 2016, Textbook of Veterinary Anatomy, 5th edn, W. B. Saunders Co.

2. Ghosh RK, 2013, Essentials of Veterinary Histology and Embryology, 3rd edn, Current Book International.
3. Ghosh RK, 2020, Primary Veterinary Anatomy (Systemic and Regional), 8th edn, Current Book International.
4. Hafez B and Hafez ESE (Eds), 2013, Reproduction in Farm Animals, 7th edn.
5. McGeady TA, 2017, Veterinary Embryology, 2nd edn, Wiley Blackwell, Singapore.
6. Reece WO, (Ed), Dukes' Physiology of Domestic Animals Ninth Edition.

Fundamentals of Crop Protection 3 (2+1)

Objectives

1. To study insects, their classification, structure and incidences
2. To study pathogens, their classification, pathogenesis and disease development
3. To study the best practices of insect and disease management

Theory

Insects – their general body structure. Importance of insects in agriculture. Life cycle of insects. Insects diversity. Feeding stages of insects and kinds (modifications) of mouthparts. Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status.

Causes of insect-pests outbreak. General symptoms of insect attack. Principles and methods of insect-pests management. Integrated Pest Management concept.

Importance and scope of plant pathology. Concept of disease in plants. Nature and classification of plant diseases. Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites.

Pathogenesis due to obligate and facultative parasites. Variability in plant pathogens. Conditions necessary for the development of disease epidemics. Survival and dispersal of plant pathogens. Management of key diseases and nematodes of major crops.

Practical

Familiarization with generalized insect's body structure and appendages. Life stages. Acquaintance with insect diversity. Identification of important insect pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage. Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silkworms. Acquaintance with various pesticidal formulations. Principles and working of common plant protection appliances. Calculation for preparing spray material.

Acquaintance with plant pathology laboratory equipment. Preparation of culture media for fungi and bacteria. Demonstration of Koch's postulates. Study of different groups of fungicides and antibiotics and methods of their evaluation. Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetable crops and their characteristic symptoms.

Suggested Reading

1. Agrios, GN, 2010, Plant Pathology. Acad. Press.
2. Atwal AS and Dhaliwal GS, 2002, Agricultural Pests of South-Asia and Their Management, Kalyani Publishers.
3. Dhaliwal GS and Arora R, 1996, Principles of Insect Pest Management, National Agriculture Technology Information Centre.
4. Dhaliwal GS, Singh R and Chhillar BS, 2006, Essentials of Agricultural Entomology, Kalyani Publishers.
5. Kumar S, 2021, Fundamentals of Plant Pathology, SBN9789390591206, NIPA.
6. Mehrotra RS and Aggarwal A, 2007, Plant Pathology, 7th Ed, Tata Mc Graw Hill Publ. Co. Ltd.
7. Sehgal PK, 2017, Fundamentals of Agricultural Entomology Unknown Binding, Kalyani Publishers.
8. Singh H, 1984, Household and Kitchen Garden Pests – Principles and Practices, Kalyani Publishers.
9. Singh RS, 2008, Plant Diseases, 8th Ed, Oxford and IBH. Pub. Co.
10. Singh RS, 2013, Introduction to Principles of Plant Pathology, Oxford and IBH Pub. Co.
11. Stakman EC and Harrar JG, 1957, Principles of Plant Pathology, Ronald Press, USA.
12. Tarr SAJ, 1964, The Principles of Plant Pathology, McMillan, London.

Livestock Product Technology 3 (2+1)

Objectives

1. To study the composition and value of milk
2. To study milk processing and milk standards
3. To study properties and values of the meet

Theory

Composition and nutritive value of milk and factors affecting composition of milk; current status of dairy industry in India. Physiochemical properties of milk. Milk Processing: milk collection, chilling, transportation, standardization, homogenization, pasteurization and packaging. Toxins and pesticide residues in milk and milk products. Organic milk food products. Bureau of Indian standards for milk and milk products; FSSAI standards for milk and milk products. Sanitation in milk plant.

Retrospect and prospects of the meat industry in India. Structure and composition of muscle (including poultry). Conversion of muscle into meat; nutritive value of meat. Meat adulteration, preservation of meat, physicochemical and microbiological quality of meat and meat products. Laws governing national, and international trade in meat and meat products, organic meat food products, and food products of genetically modified animals.

Practical

Sampling of milk, estimation of fat, solids-not-fat (SNF) and total solids. Determination of specific gravity of milk. Platform tests, cream separation. Microbiological quality of milk, meat and meat products. Visit modern milk and meat processing units.

Suggested Reading

1. Sharma BD, 1999, Meat and Meat Products Technology: Including Poultry Products Technology, Jaypee Bros Medical Publishers.
2. Sukumar D, 2001, Outlines of Dairy Technology, Oxford University Press.

Biomathematics 2 (2+0)

Objectives

1. This study the basic theories of mathematics
2. To study factor reduction and eigenvalues
3. To study the applications of biomathematics

Theory

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series. Partial differentiation, Euler's theorem on homogeneous function, change of variable. Jacobian, maxima and minima of two or more than two variables eigen values and eigen vectors of a matrix. Reduction formulae, definite integrals and its applications.

Solution of ordinary differential equation of first degree and first order and their application for determination of the volume of blood and drug distribution. Epidemic models, simultaneous differential equation of first order and their applications to predator models. Linear differential equations of higher order and their applications to the simple biological problem. Numerical methods for solving algebraic and transcendental equations.

Suggested Reading

1. Grewal BS, 2013, Higher Engineering Mathematics, Khanna Publishers.
2. Rastogi SK, 2008, Biomathematics, Krishna Prakashan Media Pvt. Ltd.
3. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol. I, PHI Learning Pvt. Ltd.
4. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol.III, PHI Learning Pvt. Ltd.

Physical Education, First Aid and Yoga Practices 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Practical

Physical education. Training and Coaching, meaning and concept. Methods of training; aerobic and aerobic exercises. Calisthenics, weight training, circuit training, interval training, Fartlek training. Effects of exercise on muscular, respiratory, circulatory and digestive systems. Balanced diet and nutrition; effects of diet on performance. Physiological changes due to ageing and role of regular exercise on ageing process. Personality, its dimensions and types. Role of sports in personality development. Motivation and achievements in sports. Learning and theories of learning. Adolescent problems and its management. Posture, postural deformities. Exercises for good posture.

Yoga; history of yoga, types of yoga, introduction to yoga. Asanas, definition and importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan. Suryanamaskar, Pranayama (Definition and Importance), Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari. Meditation, definition and importance, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh. Mudras, definition and importance, Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. Teaching of asanas, demonstration, practice, correction and practice.

History of sports and ancient games. Governance of sports in India. Important national sporting events. Awards in sports. History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First aid equipment and upkeep. First aid techniques. First aid related with respiratory system. First aid related with heart, blood and circulation. First aid related with wounds and injuries. First aid related with bones, joints, muscle related injuries. First aid related with nervous system and unconsciousness. First aid related with gastrointestinal tract. First aid related with skin, burns. First aid related with poisoning. First aid related with bites and stings. First aid related with sense organs. Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Methods in Recombinant DNA Technology 2 (0+2)

Objectives

1. Hands on training on good laboratory practices, media and stock preparation
2. To enable skill development by providing hands-on training on methods in recombinant DNA technology

Practical

Preparation of growth, madia, stock solutions and buffers. Plasmid DNA isolation. Quality and quantity assessmentof DNA. Restriction digestion of DNA. Agarose gel electrophoresis. Preparation of competent cells and genetic transformation of *E. coli*. Screening of recombinant DNA clones in *E. coli*. Confirmationof recombinant clones.

Suggested Reading

1. Carson S and Robertson D, 2005, Manipulation and Expression of Recombinant DNA, Elsevier.
2. Glick BR and Patten CL, 2022, Molecular biotechnology: principles and applications of recombinant DNA, John Wiley and Sons.
3. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual, 4th edn, Cold Spring Harbor.

Semester IV

Introductory Bioinformatics 4 (3+1)

Objectives

1. To train the students on applications of computers on analyzing the biomolecules (DNA, RNA and protein)
2. To study various types of databases
3. To study various operations and algorithms in bioinformatics

Theory

Introduction to bioinformatics. Development and scope of bioinformatics. Applications of computers in bioinformatics. Operating systems, hardware, software, internet, www resources, FTP, application of bioinformatics in agriculture.

Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam; Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: GenBank, EMBL, FASTA, PDB, Flat file, ASN.1, XML.

Introduction to sequence alignment and its applications. Pairwise and multiple sequence alignment, the concept of local and global alignment; Algorithms. Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman). Tools of MSA: ClustalW, TCoffee. Phylogeny. Introduction to BLAST and FASTA; MSA and phylogeny. Assembly and annotation.

Practical

Hands-on training on databases, database construction and management, algorithms and analysis of DNA, RNA and proteins.

Suggested Reading

1. Baxevanis AD, Ouellette BFF, 2011, Bioinformatics: A practical guide to the analysis of genes and proteins, John Wiley and Sons.
2. Mount DW, 2001, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
3. Xiong J, 2012, Essential Bioinformatics, Cambridge University Press.

Molecular Marker Technology 2(2+0)

Objectives

1. To study the importance and types of molecular markers
2. To study the mapping populations; development and analysis
3. To study the applications of molecular markers in mapping and breeding

Theory

Types of molecular markers - RFLP; PCR-based markers like RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants. Uses of molecular markers. Application as a genetic tool for genotyping

and gene mapping. Mapping populations: F_2, DH, RILs, NILs. Bulked segregant analysis, linkage maps, physical maps.

Application of molecular markers. Assessing genetic diversity, variety protection. Introduction to genomic selection, marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits. Human and animal health. Association with genetic-based diseases. Paternity determinations. Parentage using SNP data. Forensic studies. DNA Fingerprinting.

Suggested Reading

1. Gupta PK, 2015, Molecular Biology and Genetic Engineering, Rastogi Publication.
2. Manikanda Boopathi N, 2013, Genetic mapping and marker-assisted selection, Springer.
3. Manikanda Boopathi N, 2020, Genetic Mapping and Marker Assisted Selection: Basics, Practice and Benefits, Springer.
4. Schook LB (ed), 2020, Gene-mapping techniques and applications, CRC Press.
5. Verma PS, 2018, Cell Biology Genetics Molecular Biology Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
6. Watson JD, Levine M, Baker TA, Gann A, Bell SP and Losick, R, 2014, Molecular Biology of the Gene, Pearson.

Biodiversity and Its Conservation 2 (2+0)

Objectives

1. To study the concepts of biodiversity
2. To study the methods of protecting biodiversity
3. To study regulations on biodiversity conservation

Theory

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: in situ and ex-situ conservation. Wildlife conservation projects in India. Protection of biodiversity for its suitable utilization. Threats to biodiversity. WCU Red data book; Biodiversity hotspots in India. National bureaus of genetic resources. Biodiversity Mapping. Biogeographical regions.

Sustainable development. Diversification of cropping system. Diversity of indigenous livestock. Threats to biodiversity; WCU Red data book. Vulnerability and extinction of flora and fauna. Endangered species in various ecosystems. Germplasm banks. Environmental impact assessment. Bioremediation and biosafety. Introduction to regulatory agencies and legislation.

Suggested Reading

1. Das MK and Choudhury BP, 2008, A Textbook on Plant Nomenclature and Biodiversity Conservation, Kalyani Publishers.
2. Gaston KJ and Spicer JI, 2004, Biodiversity An Introduction, Blackwell Publishers.
3. Hopsetti BB. and Venketashwarlaru M, 2001, Trends in Wild Life Conservation and Management, Vol. 2, Daya Publishing House.
4. Singh MP and Singh BS, 2002, Plant Biodiversity and Taxonomy, Daya Publishing House.

Basic Biochemistry 4 (3+1)

Objectives

1. To study the structure and functions of biomolecules of living organisms
2. To study metabolism and bioenergetics
3. To study secondary metabolites and their applications

Theory

Introduction and importance. Biomolecules: carbohydrates, lipids, proteins and nucleic acids – structure, functions and properties. Acids, bases and buffers of living systems. The pK of biomolecules. Vitamins and hormones.

Bioenergetics. Metabolism – basic concept: glycolysis, citric acid cycle, glycogenesis, glycogenolysis, oxidative phosphorylation, fatty acid oxidation; Ketone bodies' metabolism.

Secondary metabolites: alkaloids, phenolics and their applications in food and pharmaceutical industries.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by TLC. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography.

Suggested Reading

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

Human Ethics 1 (1+0)

Objectives

1. To study the meaning and concepts of human behaviour
2. To study human ethical values
3. To study spirituality and attitude
4. To study the methods of stress management

Theory

Universal human aspirations. Happiness and prosperity. Human values and ethics. Concept, definition, significance and sources. Fundamental values. Right conduct, peace, truth, love and non-violence. Ethics: professional, environmental, ICT. Sensitization towards others particularly senior citizens, developmentally challenged and gender.

Spirituality, positive attitude and scientific temper. Teamwork and volunteering. Rights and responsibilities. Road safety. Human relations and family harmony. Modern challenges and value conflict. Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT Analysis). Management of anger and stress.

Suggested Reading

1. Gaur RR, Sangal R and Bagaria GP, 2011, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. Mathur SS, 2010, Education for Values, Environment and Human Rights, RSA International.
3. Sharma RA, 2011, Human Values and Education -Axiology, Inculcation and Research, R. Lall Book Depot.
4. Sharma RP and Sharma M, 2011, Value Education and Professional Ethics, Kanishka Publishers.
5. Srivastava S, 2011, Human Values and Professional Ethics, S K Kataria and Sons.
6. Srivastava S, 2011, Environmental Science, S K Kataria and Sons.
7. Tripathi AN, 2009, Human Values, New Age International (P) Ltd Publishers.

Agricultural Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs. Role of Government in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India. Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading. Agricultural prices and policy. Meaning and functions of price; administered prices; need for innovations in agricultural price policy. Trade: concept of international trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and

its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities. Study of relationship between market arrivals and prices of some selected commodities. Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities. Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class. Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Reading

1. Acharya, SS, and Agarwal NL, 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna SS, 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Kohls RL, and Uhl JN, 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
4. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
5. Lekhi RK and Singh J, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
6. Memoria CB, Joshi RL and Mulla NI, 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
7. Pandey M and Tewari, D, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.
8. Salvator D, 2008, Microeconomics: Theory and Applications, New York: Oxford University Press.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system. Definition and types, applications of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical

analysis, mathematical expressions, database, concepts and types, creating database. Uses of DBMS in agriculture, internet and World Wide Web (WWW); concepts and components.

Computer programming. General concepts, introduction to visual basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, application of innovative ways to use information and communication technologies (IT) in agriculture, computer models in agriculture. Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops. Computer-controlled devices (automated systems) for agri-input management, smartphone mobile apps in agriculture for farm advice. Market price, postharvest management etc. Geospatial technology; concepts, techniques, components and uses for generating valuable agri-information. Decision support systems; concepts, components and applications in agriculture. Agriculture expert system, soil information systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet. Use of statistical tools. Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS, creating database, preparing queries and reports, demonstration of agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Reading

1. Date CJ, 2007, An introduction to Database Systems, Addison-Wesley.
2. Dhabal PS and Manoranjan P, 2017, Concepts and Techniques of Programming in C, I.K. International Publishing House Pvt. Limited.

3. ITL Education Solutions Ltd, 2006, Introduction to Information Technology, PEARSON Education.
4. Mahapatra SK, Mishra P and Pradhan J, 2022, Introductory Agri Informatics, Jain Brothers.
5. Rajaroman V and Adabala N, 2015, Fundamentals of Computer, PHI Learning Private Ltd, New Delhi.

Practices in Molecular Marker Technology 2 (0+2)

Objectives

1. This course aims at imparting skills through hands-on training in the area of molecular markers and their applications
2. To study the development of markers and marker systems, genotyping with various types of markers, mapping, diversity analysis, marker-assisted selection, DNA fingerprinting, diversity and cluster analysis, phylogenetic analysis

Practical

Overview of molecular markers: types, applications, significance. Principles of genetic variation and inheritance, DNA Extraction and quantification, PCR-Based molecular markers, RFLP (Restriction Fragment Length Polymorphism) analysis, AFLP (Amplified Fragment Length Polymorphism) analysis, SSR (Simple Sequence Repeat) analysis, SNP (Single Nucleotide Polymorphism) analysis. Principles of SNP detection, PCR-based SNP genotyping assays, SNP array and sequencing-based approaches. DNA sequencing and sequence analysis, interpretation of sequencing data and sequence alignment, Marker-Assisted Selection (MAS), genomic selection and marker discovery. Practical Project: students design and conduct a small-scale molecular marker project. They will choose a specific technique or experiment, perform the necessary procedures, analyze data, and present their findings.

Suggested Reading

1. Gupta PK, 2015, Molecular Biology and Genetic Engineering, Rastogi Publication.
2. Manikanda Boopathi N, 2013, Genetic mapping and marker-assisted selection, Springer.
3. Manikanda Boopathi N, 2020, Genetic Mapping and Marker Assisted Selection: Basics, Practice and Benefits, Springer.
4. Schook LB (ed), 2020, Gene-mapping techniques and applications, CRC Press.
5. Verma PS, 2018, Cell Biology Genetics Molecular Biology Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
6. Watson JD, Levine M, Baker TA, Gann A, Bell SP and Losick, R, 2014, Molecular Biology of the Gene, Pearson.

Semester V

Microbial Genetics 4 (3+1)

Objectives

1. To provide an understanding of using microorganisms for genetic analyses

2. To study genetic variability and recombination among microbes
3. To study plasmids, their types and use in recombinant DNA technology

Theory

Microorganisms as tools for genetic studies. Genetic variability in microorganisms. Genetic analysis of representative groups of bacteria, fungi and viruses. Random and tetrad spore analysis. Recombination and chromosomal mapping. Complementation - intergenic and intragenic.

Bacterial plasmids. Structure, life cycle, mode of infection and their role in genetic engineering. Transfer of genetic material in bacteria. Conjugation, transformation and transduction. Genetics of bacteriophage: T4, lambda and M13, life cycle, mode of infection. Mutation: types, mutagens, DNA damage and repair. Transposable elements; Lac operon, yeast genetics.

Concept and application of recombinant DNA technology. Use of genetic tools to improve the microbial strains for industry, agriculture and health.

Practical

Conjugation and transformation in bacteria. Spontaneous and auxotrophic mutation. Chemical and UV mutagenesis in fungi and bacteria.Complementation in fungi. Identification of mutants using replica plating technique. Isolation of genomic DNA from *E. coli*. Isolation and curing of plasmid. Identification of plasmid by electrophoresis / antibiotic plates.

Suggested Reading

1. Michael RG and Joseph S, 2012, Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press.
2. Reece RJ, 2013, Analysis of Genes and Genomes, Wiley.

Molecular Genetics 3 (3+0)

Objectives

1. This course introduces DNA structure and function
2. To study DNA functions like replication and gene expression
3. To provide an understanding of gene regulation in prokaryotes and eukaryotes

Theory

Structures, properties and modification of DNA. Molecular mechanisms of DNA replication, repair. Types of mutation. Linkage and recombination. Molecular mechanisms of crossing over. Centromere and telomere sequences, and DNA packaging. Repetitive DNA sequences and transposable elements. Markers and QTL.Synthesis and processing of RNA and proteins. Regulation of gene expression.

Genetic code, properties of genetic code, structure of a gene, promoters and their isolation. Synthesis and processing of RNA.

Regulation of gene expression. Transcription factors – their classification and role in gene expression. Epigenetic control of gene expression. Analysis of gene expression. Small RNAs, RNA interference and its applications.

Suggested Reading

1. Allison LA, 2011, Fundamental Molecular Biology, Wiley Global Education.
2. Brown TA, 1998, Genetics: A Molecular Approach, 3rd edn, Stanley Thornes.
3. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics, John Wiley and Sons, Inc, New York, USA.
4. Hartl DL, 2021, Essential genetics and genomics, 7th edn, Jones and Bartlett Learning.
5. Lewin B, 2009, Genes, Jones and Bartlett Learning.
6. Lewin B, 2017, Gene XII, Oxford University Press.
7. Tropp BE, 2014, Principles of Molecular Biology, Jones and Bartlett Learning.
8. Tropp BE. 2012. Molecular Biology: Genes to Proteins, 4th edn, Jones and Bartlett Learning.

Nanobiotechnology 4 (3+1)

Objectives

1. To provide an understanding of the concepts and terminologies related to nanobiotechnology
2. To study nanosystems, their synthesis and application

Theory

Introduction to nanotechnology. Concepts and Terminology. Nano-Bio Interface. Biological-based nanosystems, molecular motors, biosensors and other devices.

Self-assembly of molecules for nanotechnology applications. Biomimetics, biotemplating and de novo designed nanostructures and materials. DNA-nanotechnology. Nanomanipulations, material design, synthesis and their applications.

Practical

Introduction to nanomaterials and their properties. Nanoscale characterization techniques. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Atomic force microscopy (AFM) for nanoscale imaging and manipulation. Spectroscopic techniques (UV-Vis, fluorescence, Raman) for nanoparticle analysis. Nanoparticle synthesis and functionalization, chemical synthesis methods for nanoparticles (top-down and bottom-up approaches), surface functionalization techniques for controlling nanoparticle properties. Biomolecular interactions at the nanoscale, nanotoxicology and safety assessment. Project and presentations.

Suggested Reading

1. Gabor L, Hornyak J, Moore J, Tibbals, HF and Joydeep D, 2009, Fundamentals of Nanotechnology, CRC Press.
2. Kumar U, 2008, Nanotechnology: A Fundamental Approach, Agrobios

Animal Biotechnology 3 (2+1)

Objectives

1. To study historical developments in animal biotechnology

2. To study the biotechnological tools for improving animal health and products
3. To study the use of molecular markers for animal genome analysis

Theory

History and development of animal biotechnology. Basic techniques in animal cell culture. Introduction to embryo biotechnology, oocyte collection and maturation. Sperm preparation. in vitro fertilization. Cryopreservation of oocyte, sperm and embryos. Embryo transfer technology.

Breeds of livestock and their characteristics. Marker-assisted breeding of livestock. Introduction to animal genomics: RFLP, RAPD, SSRs, QTL, SNP, STR, mitochondrial DNA polymorphism. Rumen and its environment. Rumen microbes - manipulation of rumen microbes for better utilization of feed. Introduction to nutrigenomics. Milk biome. Manipulation of lactation by biotechnological tools. Application of biotechnology in meat and meat products.

Genome and protein-based diagnostics of important animal diseases: FMD, brucellosis, PPR, mastitis, bluetongue, newcastle disease. Introduction to vaccinology, live attenuated vaccines, killed vaccines, cell culture-based vaccines, recombinant vaccines.

Practical

Basic cell culture techniques, oocyte aspiration from ovaries, sperm preparation, in vitro fertilization. PCR-based detection of animal pathogens. PCR-RFLP. Immunohistochemical localization of protein marker in tissues/cells – meat species identification by PCR.

Suggested Reading

1. Singh B, Gautam SK, Chauhan MS and Singla SK, 2015, Textbook of Animal Biotechnology, The Energy and Resources Institute, TERI.
2. Srivastava AK and Singh RK, 2018, Animal Biotechnology, CBS Publishers and Distributors, ISBN 9788120416482, 8120416481.

Genomics and Proteomics 3 (3+0)

Objectives

1. To provide an understanding of genomics; structural and functional
2. To study comparative genomics and its applications
3. To study proteomics and related tools

Theory

Introduction to genomics. Functional genomics and proteomics. Structural genomics: classical ways of genome analysis. BAC and YAC libraries. Next generation sequencing. Genome analysis and gene annotation. Genome projects: *E. coli*, Arabidopsis, Bovine, Human. Comparative Genomics: orthologous and paralogous sequences. Synteny, gene order, phylogenetic footprinting.

Functional genomics: Differential gene expression techniques: ESTs, cDNA-AFLP, microarray, Differential display, SAGE, RNAseq, Real-time PCR

Introduction to proteomics. Analysis of proteome. Native PAGE, SDS PAGE, 2D PAGE. Edmann Degradation. Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDI-TOF, LC-MS, SWATH-MS. Post Translational modifications.

Suggested Reading

1. Andreas H and Samuel C, 2018, Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
2. Saraswathy N, Ramalingam P, 2011, Concepts and Techniques in Genomics and Proteomics, Elsevier Science.

Enzymology and Enzyme Technologies 3 (2+1)

Objectives

1. To study the basic structure, function and types of enzymes.
2. To study enzyme kinetics, regulation of enzyme activity and applications of enzymes.

Theory

Classification and nomenclature of enzymes. General characteristics of enzymes, active site, cofactors, prosthetic groups. Metalloenzymes; Isolation, purification, characterization and assays of enzyme and international units. Criteria for purity.

Enzyme kinetics, effect of pH, temperature, determination of Km and Vmax. Regulation of enzyme activity. Enzyme inhibition. competitive, non-competitive and uncompetitive. Isoenzymes, schizomers and isoschizomers. Ribozymes. Immobilization of enzymes. Applications of enzymes; biotechnology, industry, environment, agriculture, food and medicine.

Practical

Isolation, purification and assay of enzymes. Determination of optimum pH and optimum temperature of enzymes. Thermostability of enzymes. Activators and inhibitors of enzyme catalysis. Immobilization of enzymes. Isoenzymes analysis.

Suggested Reading

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

Immunology 3 (2+1)

Objectives

1. To study the meaning and importance of immunology
2. To study the classes of antigens and antibodies
3. To study the immunological techniques and DNA vaccines

Theory

History and scope of immunology. Components of the immune system: organs, tissues and cells. Immunoglobulin structure and functions. Molecular organization of immunoglobulins and classes of antibodies. Antibody diversity; antigens, haptens, antigens antibody interactions. Immuno-regulation and tolerance.

Allergies and hypersensitive response. Immunodeficiency. Concept of Vaccines and Vaccinology. Conventional Vaccines. Recombinant subunit vaccines. DNA vaccines and vectored

vaccines. Immunological techniques. Immunological application in animal science, monoclonal antibodies and their uses.

Practical

Preparation of buffers and reagents. Precipitation and agglutination test; HA, HI test; immunoblotting, immune electrophoresis and fluorescent antibody test; enzyme immunoassays including ELISA variants, Western blotting. Raising of antisera in laboratory animals. Collection and preservation of antisera – separation, filtration and aliquoting.

Suggested Reading

1. Judy O, Jenni P, Sharon S and Patricia J, 2018, Kuby Immunology.

Semester VI

Molecular Diagnostics 3 (2+1)

Objectives

1. To understand the importance of molecular diagnostics
2. To acquaint with various methods of diagnostic methods
3. To compare the advantages of molecular diagnostic methods with those of conventional methods

Theory

Principle and applications of molecular diagnostic tests. Nucleic acid-based diagnostics for detection of pathogenic organisms. Application of restriction endonuclease analysis for identification of pathogens. Polymerase chain reaction (PCR) and its variants. Reverse transcriptase polymerase chain reaction (RT-PCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting. Protein-based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA and lateral flow device.

Advantages of molecular diagnostics over conventional diagnostics, serodiagnostic, DNA array technology, Protein array, tissue array. Biosensors and nanotechnology. Development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents. Collection of clinical and environmental samples for molecular detection of pathogens (bacteria/virus). Extraction of nucleic acids (DNA and RNA) from the clinical specimens. Restriction endonuclease digestion and analysis using agarose gel electrophoresis. Polymerase chain reaction for detection of pathogens in blood and animal tissues. RT-PCR for detection of RNA viruses. PCR based detection of meat adulteration in processed and unprocessed meats. PCR based detection of pathogens in milk, eggs and meat. Lateral flow assay, ELISA.

Suggested Reading

1. Lela B, 2019, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, FA Davis Company.
2. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

Industrial Biotechnology 3 (3+0)

Objectives

1. To understand various industrial bioprocesses
2. To acquaint with the production of primary metabolites and secondary metabolites
3. To study the industrial production of bioproducts

Theory

Introduction to industrial bioprocess. Fermentation- bacterial, fungal and yeast. Traditional and modern biotechnology- a brief survey of organisms, processes, and products. Basic concepts of upstream and downstream processing in bioprocess.

Production of primary metabolites. Primary metabolites- production of commercially important primary metabolites like organic acids, and alcohols.

Production of secondary metabolites. Secondary metabolites- production processes for various classes of secondary metabolites: antibiotics, vitamins and steroids.

Production of bioproducts. Production of biopesticides, biofertilizers, biopreservatives, biopolymers biodiesel. bheese, beer, and bushroom culture, bioremediation.

Suggested Reading

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J and Kunthala J, 2004, Concepts in Biotechnology, Universities Press Pvt.Ltd.
2. Dubey RC, 2006, A Textbook of Biotechnology, S. Chand and Sons.
3. Kumar HD, 1998, A Textbook on Biotechnology, 2nd edn, Affiliated East West Press Pvt.
4. Ratledge C, and Bjorn K, 2001, Basic Biotechnology, 2nd edn, Cambridge University Press.

Epigenetics and Gene Regulation 2 (2+0)

Objectives

1. To have an understanding the epigenetics; its manifestation and consequences
2. To study the forms of DNA and histone modifications and their role in gene regulation
3. To study the influence of epigenetics on the small RNAs

Theory

DNA methylation and histone modifications. DNA methylases, methyl binding proteins and histone modifiers. Epigenetic changes in response to external stimuli leading to changes in gene regulation. Role of DNA methylation in plant development: mutant case studies.

Introduction to small RNAs. History, biogenesis. In silico predictions, target gene identification, methylation of heterochromatin by het associated siRNAs. Gene regulation by small RNA and other classes of siRNAs. Role in epigenetics. Jacob Monod model, RNA editing, genome imprinting.

Suggested Reading

1. Sambrook JF and Russell DW (Ed), 2001, Molecular Cloning: A Laboratory Manual, 3rd edn, Vols 1, 2 and 3, Cold Spring Harbor Laboratory Press.

2. Mohanpuria P, Kumar V, Mahajan M, Mohammad H and Yadav SK, 2010, Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues, Nova Science Publishers.

IPR, Biosafety and Bioethics 2 (2+0)

Objectives

1. To study the importance and forms of IPR.
2. To study the role of IPR in connection with biodiversity and research outcomes.
3. To study the biosafety guidelines for handling the GMOs.

Theory

Introduction to Intellectual Property, concepts and types. International treaties for the protection of Ips. Indian Legislations for the protection of various types of intellectual property. Patent search, filing process. Material transfer agreements.

Biodiversity definition, importance and geographical causes for diversity. Species and population biodiversity, maintenance of ecological biodiversity hot spots in India. Convention on biological diversity. Cartagena protocol of bio-safety, and risk management for GMO's. Bio-safety guidelines, rules and regulations and regulatory framework for GMOs in India.

Suggested Reading

1. Deepa G and Shomini P, 2013. IPR, Biosafety and Bioethics, Pearson Education.
2. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

Computational Biology 3 (2+1)

Objectives

1. To study the basics of web-based servers and software in genome analysis.
2. To study the procedure and steps in DNA/RNA/protein sequence submission
3. To study the methods of analysing the sequences for similarity and phylogenetics

Theory

Introduction to computational biology. Web-based servers and software for genome analysis. Ensembl, UCSC genome browser, MUMMER, BLASTZ. Sequence submission: sequence submission, whole genome sequence submission; NGS: basics and types. Introduction to bioprogramming; Perl, Python and R development of web server; basic concepts.

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE. Principles of Protein structure prediction. Fold Recognition (threading). Homology modeling. SCOP, CATH, PDB, PROSITE, PFAM. Methods for comparison of 3D structures of proteins.

Phylogenetic analysis. Evolutionary models, tree construction methods, statistical evaluation of tree methods; PHYLIP, dendroscope, MEGA; DNA barcoding database-BOLD.

Practical

Application of Genome browsers in genomic research. Exploring protein-protein interaction databases. Working with protein structural classification databases. SNP and SSR identification tools; PHYLIP.

Suggested Reading

1. Creighton TE, 1993, Proteins: Structures and Molecular Properties, 2nd edn, W. H. Freeman.
2. Dov S, 2003, Microarray Bioinformatics, 1st edn, Cambridge University Press.
3. Malcolm Campbell A and Laurie JH, 2007, Discovering Genomics, Proteomics and Bioinformatics. 2nd edn, Benjamin Cummings.
4. Mount D, 2001, Bioinformatics: Sequence and Genome Analysis, 2nd edn, Cold Spring Harbor Laboratory Press.
5. Setubal J and Meidanis J, 2004, Introduction to Computational Molecular Biology, PWS Publishing Company.

Introduction to Animal Breeding 3 (2+1)

Objectives

1. To study the developments and goals of animal breeding
2. To study population genetics
3. To study the methods of animal breeding

Theory

Population and population genetics; Hardy- Weinberg law; Hardy Weinberg equilibrium. Approaching to equilibrium for sex-linked trait; linkage equilibrium. Effect of linkage on HW-equilibrium. Stochastic and deterministic forces acting on population; mutation; migration; selection.

Dissection of phenotype into its components. Transmitting ability, substitution effect of allele. Breeding value. Definition, concept. Heritability: definition, concept, estimation of heritability from regression of offspring to parents. Resemblance among relatives. Repeatability. Definition, concept and estimation. Correlated traits. Phenotypic and genetic correlation, environmental correlation, selection index. Basic concept and types. Basis of selection. Selection differential and genetic gain.

Breeding strategies in large ruminants (cattle, buffalo), small ruminants (sheep, goat) and swine. Poultry breeding. Lab animal breeding. Breed improvement program conducted in India. Molecular breeding: complementation of traditional breeding strategies with molecular genetics.

Practical

Chi-squared test for determining goodness of fit for HW-equilibrium. Estimation of effect of allelic substitution. Estimation of heritability, regression of offspring on parents. Estimation of repeatability. Phenotypic correlation, genetic correlation, environmental correlation. Chi-squared test for determining goodness of fit for HW-equilibrium. Linkage analysis from pedigree data. Selection index.

Suggested Reading

1. Brah GS, 2014, Animal Genetics: Concepts and Implications, 2nd edn, Kalyani Publishers.
2. Mackay TFC and Falconer DS, 2009, Introduction to quantitative genetics, 4th edn, Pearson.

Biostatistics 2 (1+1)

Objectives

1. To study the variables and descriptive statistics
2. To study various distributions
3. To study experimental data analysis and interpretation

Theory

Random variables: expected value and its variance; probability distribution of random variables. Conditional probability. Baye's theorem and its applications. Introduction to uniform, binomial, poisson, normal, exponential and gamma probability distributions.

Random mating populations, Hardy-Weinberg Law. Introduction to poisson process and Markov chains. Transition probability matrix, n-step transition probabilities, steady state. Random walk models. Sensitivity and specificity. Positive and negative predictive values.

Chi-square test: testing heterogeneity, use in the genetic experiment, detection of linkage, linkage ratios and its estimation. Analysis of variance. One-way and two-way classification with interaction. Analysis of covariance. Incomplete block designs. Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions. Uniform, binomial, poisson, normal, nxponential and namma probability distributions. Hardy-Weinberg Law. Construction of transition probability matrix in Markov Chains. Calculation of sensitivity and specificity. Positive and negative predictive values. Detection and linkage using chi-square test; one-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Estimation of heritability.

Suggested Reading

1. Gupta SC, Kapoor VK, 2007, Fundamentals of applied statistics, 4th edn, S Chand and Sons.
2. Kaps M and Lamberson WR, 2017, Biostatistics for Animal Science, 3rd edn, CABI.
3. Triola MM, Triola MF and Roy J, 2017, Biostatistics for the Biological and Health Sciences, 2nd edn, Pearson.

Food Science and Processing 3 (2+1)

Objectives

1. To study food and nutrition for good health
2. To study food spoilage, processing and preservation
3. To study the methods of assessing physical and chemical qualities

Theory

Definition: Food and nutrition. Food production and consumption trends in India. Major deficiencies of calories, proteins, vitamins and micronutrients. Food groups and concept of balanced diet. RDA, biotoxins, anti-nutritional factors and metabolites.

Causes of food spoilage. Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation. Preservation through ultraviolet and ionizing radiations.

Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry. Food safety, adulteration and food laws. Status of food industry in India

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry. Value-added products from cereals, millets, fruits, vegetables, milk, egg and meat. Visit to local processing units.

Suggested Reading

1. Potter NN and Hotchkiss JH, 1995, Food Science, Chapman and Hall Publishers.
2. Swaminathan M, 2005, Handbook of Foods and Nutrition, Ganesh and Co. Pvt. Ltd.
3. Swaminathan M, 1990, Food Science, Chemistry and Experimental Foods, BAPPCO.
4. Vaclavik VA and Christian EW, 2003, Essentials of Food Science, 2nd edn, Kluwer Academic/ Plenum Publishers, New York.

Semester VII

Elective Courses

Applications of Genomics and Proteomics 4 (3+1)

Objectives

1. To introduce the concepts of omics; genomics, transcriptomics and proteomics
2. To study the methods in genomics and their applications
3. To study the techniques in proteomics

Theory

Genomes of Arabidopsis, rice, tomato, pigeon pea, wheat. Mutants and RNAi in functional genomics. Site-directed mutagenesis. Transposon tagging. Transient gene expression: VIGS and FACS based, targeted genome editing technologies, introductory genome editing principle and concepts.

Protein 3D structure modelling (homology modelling and crystallography). Proteome analysis. Protein-protein interaction. FRET, yeast two-hybrid and co-immunoprecipitation, Bimolecular Fluorescence Complementation (BiFC). Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways.

Practical

SDS-PAGE; 2D Electrophoresis. Protein characterization through HPLC. Specialized crop-based genomic resources: TAIR, Gramene, Graingenes, Maizedb, Phytozome, C e re a l d b, Citrusdb and miRbase.

Suggested Reading

1. Connor DO and Hames BD, 2007, Proteomics: Methods Express, Royal College of General Practitioners.
2. Pennington SR, Dunn MJ, 2001, Proteomics from protein sequence to function, BIOS Scientific Publishers Ltd.
3. Sangeetha J and Thangadurai D, 2015, Genomics and Proteomics: Principles Technologies and Applications, Taylor and Francis
4. Tropp BE, 2012, Molecular Biology Genes to Proteins, 4th edn, Jones and Bartlett Learning.
5. Verma PS and Agarwal VK, 2014, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.+

Principles of Molecular Breeding 4 (3+1)

Objectives

1. To introduce the concept of molecular breeding with reference to conventional breeding
2. To study the mapping populations, genotyping, phenotyping and mapping
3. To study the validation of genomic resources and their employment in breeding

Theory

Introduction to molecular breeding, advantages, requirements and methodologies. Limitations of conventional breeding. Development of specific mapping populations, association panels, MAGIC and NAM populations.

Phenotyping and genotyping of the populations, construction of the linkage maps, and linkage-disequilibrium maps. Analysing marker-trait associations, validation of QTL and markers, fine-mapping, and candidate gene discovery.

Marker-assisted selection (MAS) and marker-assisted backcross breeding. Foreground selection, background selection and recombination selection. MAS for major and minor genes, marker-assisted pyramiding, and marker-assisted recurrent selection.

Practical

Methodologies in phenotyping, genotyping, handling marker data, linkage analysis, candidate gene discovery, and fine-mapping. Software for linkage mapping and association mapping. Working on some genotyping and phenotyping datasets for linkage mapping using software such as Mapmaker, MapDisto and QTL mapping software such as WinQTL Cartographer.

Suggested Reading

1. Bharadwaj DN, 2019, Molecular Plant Breeding: Meeting the Challenge of Food Security, Apple Academic Press.
2. Xu Y, 2010, Molecular Plant Breeding, CABI, Science.
3. Singh BD and Shekhawat NS, 2017, Molecular Plant Breeding, Scientific Publishers.

Principles and Procedures of Plant Tissue Culture 3 (2+1)

Objectives

1. To understand the concept of totipotency and its applications in plant tissue culture
2. To study the composition of plant tissue culture media and the role of different components
3. To study the principles, procedures and uses of various types of cultures

Theory

History of plant tissue culture. Concept of totipotency. Concept of aseptic culture practices and sterilization techniques. Components of *in vitro* culture media and role of different macro and micronutrients, vitamins, plant growth regulators and growth supplements. Various plant cell, tissue and organ culture techniques and uses. Somatic cell cultures. Morphogenesis: organogenesis and somatic embryogenesis. Micropropagation; *In vitro* grafting. Meristem culture. Anther, pollen. embryo, ovule and ovary culture. Protoplast culture and somatic hybridization. Somaclonal variation.

Practical

Good laboratory practices. Media preparation and sterilization. Surface sterilization of explants. Establishment of callus/cell suspension cultures. Micropropagation. Embryo culture. Anther culture. Induction of plant regeneration. Hardening and transfer to soil.

Suggested Reading

1. Bhojwani SS and Razdan MK, 1996, Plant Tissue Culture: Theory and Practice, Elsevier.
2. Chawla HS, 2009, Introduction to Plant Biotechnology: Oxford & IBH Publishing Co Pvt. Ltd.
3. Dixon RA and Gonzales RA, 2003, Plant Cell Culture: A Practical Approach, Oxford University Press.
4. Razdan MK, 2008, Introduction to Plant Tissue Culture: Oxford & IBH Publishing Co Pvt. Ltd.

Molecular Breeding in Field and Horticultural Crops 3 (2+1)

Objectives

1. To study the principles and applications of molecular breeding in field and horticultural crops
2. To understand breeding objectives in field and horticultural crops
3. To study the success stories of molecular breeding in field and horticultural crops

Theory

MAS for specific traits with examples from field crops with success stories. Development, testing and release of improved genotypes developed using MAS. Specific case studies. Reproductive biology of major field and horticultural crops. Target traits in major field and horticultural crops. Breeding methods of self- and cross-pollinated field and horticultural crops. Pseudo test cross-mapping strategy in fruit crops. Molecular mapping in vegetable crops. Marker-assisted breeding in field and horticultural. Mutation breeding and characterization of mutants.

Practical

Use of gene-based and closely linked markers for foreground selection for target traits in target field crops. Hands-on training on MAS with a specific crop. Modifications in DNA extraction

methods for field and horticultural. Agarose gel electrophoresis, and DNA quantification. Mapmaker; Diversity analysis using UPGMA. Identifying repeat sequences using MISA. Standard gene cloning and expression methods.

Suggested Reading

1. Bal JS, 2013, Fruit Growing, Kalyani Publishers.
2. Bharadwaj DN, 2019, Molecular Plant Breeding: Meeting the Challenge of Food Security, Apple Academic Press
3. Chada KL, 2012, Handbook of Horticulture, ICAR.
4. Kumar N, 2006, Breeding of Horticultural crops: Principles and Practices, New India Publishing Agency.
5. Kumar N, 2018, Breeding of Horticultural Crops: Principles and Practices: 3rd edn, NIPA.
6. Nagat T, Lorz H and Widholm JM, 2008, Biotechnology in Agriculture and Forestry, Springer.
7. Schnell RJ and Priyadarshan PM, 2012, Genomics of Tree Crops, Springer.
8. Singh BD and Shekhawat NS, 2017, Molecular Plant Breeding, Scientific Publishers.
9. Singh J, 2014, Basic Horticulture, Kalyani Publishers.
10. Singh R, 2012, Fruits. National Book Trust.
11. Spangenberg G, 2001, Molecular Breeding of Forage Crops, Kluwer Academic Publishers.
12. Trivedi PC, 2000, Plant Biotechnology: Recent Advances, Panima Publishers.
13. Xu Y, 2010, Molecular Plant Breeding, CABI, Science.

Seed Biology, Biotechnology, Production and Management 3 (2+1)

Objectives

1. To provide an overview of the aspects of seed biology
2. To study the principles and methods of quality seed production
3. To study the techniques and management for seed processing

Theory

Seed structure, seed development and maturation. Seed germination. Seed senescence- causes, quality characters.

Molecular seed biology: gene expression during seed development, molecular markers and seed quality, omics technologies in seed research and male sterility systems. Biofortification and seed enhancement, seed coatings and treatments, biopesticides and biofertilizers. Advances in seed biotechnology, sustainable seed production practices and future challenges and opportunities in seed science.

Principles of quality seed production. Factors affecting quality seed production. Causes of varietal deterioration and maintenance of genetic purity during seed production.

Post-harvest handling of seeds - threshing methods - drying methods - advantages and disadvantages. Seed processing principles and sequencing. Seed enhancement technologies (coating, priming, pelleting and hardening)

Practical

Seed production in rice varieties and hybrids. Seed production in sorghum varieties and hybrids. Seed production in pearl millet varieties and hybrids. Seed production in maize. Hybrid seed production in maize. Seed production in pulses (black gram and green gram and red gram). Seed production in groundnut and gingelly. Seed production in sunflower varieties and hybrids. Seed production in cotton. Seed production in solanaceous vegetables. seed production techniques of bhendi and onion. Seed production in cucurbits (snake gourd, bitter gourd, ash gourd, ridge gourd and pumpkin).

Suggested Reading

1. Basra A, 2006, Handbook of Seed Science and Technology (Seed Biology, Production, and Technology), CRC Press.
2. Khedar OP, Singh RV, Sinsinwar YK and Ved Prakash V, 2013, Seed Production Technology in Field Crops, Pointer, ISBN 10: 817132746XISBN 13: 9788171327461

Plant Genetic Transformation 3 (2+1)

Objectives

1. To study the historical developments of plant transformation
2. To study the methods of plant transformation
3. To get acquainted with the methods used for analysing the transgenics

Theory

History of plant genetic transformation. Development of gene constructs. Methods of genetic transformation: *Agrobacterium*-mediated, biolistics, electroporation, liposome, polyethylene glycol, in planta methods.

Selection and characterization of transgenic plants using selectable and reportable markers. PCR; qRT-PCR; Southern and Northern hybridization, ELISA and Western blotting. Application of genetic transformation for improvement of important traits. Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions. Construction of binary vector. Preparation of competent cells of *Agrobacterium tumefaciens* and transformation. Restriction analysis of plasmids, confirmation of transformed bacterial colonies. *Agrobacterium tumefaciens* mediated and biolistic plant transformation.

Suggested Reading

1. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics. John Wiley and Sons, Inc, New York, USA.
2. Grierson D, 2012, Plant Genetic Engineering, Springer Netherlands.
3. Primose SB and Twyman RM, 2006, Principles of Gene Manipulation and Genomics, 7th edn, Black Well Publishing.

4. Sambrook JF and Russell DW (Ed), 2001, Molecular Cloning: A Laboratory Manual, 3rd edn, Vols 1, 2 and 3, Cold Spring Harbor Laboratory Press.
5. Stewart NC, 2008, Plant Biotechnology and Genetics: Principles, Techniques and Applications, John Wiley and Sons Inc.

Principles and Procedures of Animal Cell Culture 4 (3+1)

Objectives

1. To study the principles and importance of animal cell culture
2. To study the basic requirements for animal cell culture
3. To study the techniques in cryopreservation and applications of animal cell culture

Theory

History, importance and development of animal cell culture techniques. Basic requirements for animal cell culture. Sterilization procedures for cell culture work. Different types of cell culture media, growth supplements, serum-free media and other cell culture reagents.

Different cell culture techniques including primary and secondary cultures; continuous cell lines, suspension culture, organ culture etc. Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636, their origin and characteristic, growth kinetics of cells in culture, differentiation of cells. Characterization and maintenance of cell lines. Applications of animal cell cultures.

Cryopreservation and revival of cells. Hybridoma technology. Scaling up methods, bioreactors. Overview of insect cell culture. Stem cell culture and its application, overview of induced pluripotent stem cells (iPSCs). Common cell culture contaminants and their management.

Practical

Basic equipments used in animal cell culture laboratories. Washing, packing and sterilization of glass and plastic wares for cell culture. Preparation of media and reagents for cell culture. Primary culture technique of chicken embryo fibroblast/any other animal tissue. Culture and sub-culturing of continuous cell lines. Viability assay by trypan blue dye exclusion method. Isolation and cultivation of lymphocytes. Cryopreservation of primary cultures and cell lines. Cytopathic effect of viruses on cultured mammalian cells.

Suggested Reading

1. Freshney I, 2016, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.

Animal Genomics 4 (3+1)

Objectives

1. To study the genome sequencing and organisation of the animal genome and chromosomal aberrations
2. To study the application of genomics in the development of molecular markers
3. To study the application of genomics and molecular markers in animals

Theory

Genome organization in eukaryotes. Satellite DNA: VNTRs and families, LINE and SINE. Sex determination: chromosomal basis of sex determination, molecular markers for sex determination, environmental sex determination. Chromosomal aberrations: euploidy, chromosomal non-disjunction and aneuploidy, polyploidy, induced polyploidy, syndromes, structural aberrations. Robertsonian translocations, position effect, chromosomal mosaics, Philadelphia chromosome, chromosomal aberrations and evolution.

Molecular markers: markers, genetic markers: RAPD, STR, DNA fingerprinting, SSCP, RFLP, SNP, EST; SNP Analysis. Karyotyping. Somatic cell hybridization, SNP-array. Radiation hybrid maps. FISH technique. Major histocompatibility complex. Concept and its relevance in disease resistance and immune response. Quantitative trait Loci. Marker Assisted Selection: concept, linkage equilibrium, application in animal sciences. Genomic selection: concept, linkage disequilibrium. Methodologies of genomic selection. Mitochondrial DNA analysis and its application in livestock; applying DNA markers for breed characterization, molecular signatures.

Practical

Extraction of genomic DNA from peripheral blood. Analysis of DNA by agarose or polyacrylamide gel electrophoresis. Checking the quality and quantity of genomic DNA. Restriction digestion and analysis. Sanger sequencing data analysis. Extraction of mitochondrial DNA. Extraction of RNA from PBMC. Quality checking of total RNA. cDNA synthesis.

Suggested Reading

1. Brown TA, 2006, Genomes. 5th edn, Wiley-Blackwell.
2. Dale JW, Schantz MV and Plant N, 2012, From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley and Sons.
3. Green and Sambrook JF and Russel DW, 2014, Molecular Cloning: A Laboratory Manual, 4th Ed, Vol I, II and III, Cold Spring Harbor Laboratory Press.
4. Reece RJ, 2004, Analysis of Genes and Genomes, Wiley.
5. Sue C, Heather BM, Scott DW and Melissa CS, 2019, Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press.

Transgenic Animal Production 3(3+0)

Objectives

1. To study the historical developments of developing transgenic animals
2. To study the methods of animal transformation
3. To get acquainted with the methods used for analysing the transgenics
4. To study the applications of transgenic animals

Theory

History of transgenesis. Isolation of gene, preparation of gene construct. Methods of transgenic animal production. Calcium chloride mediated transfection, lipofection, electroporation, microinjection, nano delivery.

Production of gene knockouts: cre-lox, zinc finger nucleases; CRISPR; TALENs. Production of chimeric animals, gene silencing by lentivirus system.

Stem cell technology, isolation and characterization of stem cell lines from different sources: embryo, mesenchymal, induced pluripotent stem cell. Introduction to animal cloning. Application of stem cells in transgenesis and animal cloning.

Fundamental assays of transgenic products: confirmation of integration of transgene. Validation of transgenic products like isolation of transgenic protein from milk and characterization. Application of transgenics in production of disease resistance models and carcinogenesis. Regulatory issues associated with transgenic animal production.

Suggested Reading

1. Pinkert CA, 2014, Transgenic Animal Technology.

Molecular Virology and Vaccine Production 3 (2+1)

Objectives

1. To study the viruses to develop vaccines
2. To study the antigens and methods of producing the vaccines
3. T study the properties of ideal vaccines

Theory

Properties of viruses. Classification of viruses. Virus replication. Cell transformations, cultivation of viruses, assay techniques for detection/quantification. Important animal viruses. Virus-host interactions. Viral infections. Immune responses to viruses. Interferon and other cytokines. Bio-safety and bio-security principles.

Properties of an ideal vaccine. Classification of vaccines. Methods of inactivation and attenuation of viruses. New generation vaccines: subunit, synthetic, rDNA, marker and edible. Adjuvants and vaccine delivery systems. Novel immunomodulators and vaccine delivery using nanotechnology. Vaccine preparation. Stabilizers, preservatives and vehicles. Quality control and testing of vaccines. Sero-surveillance and sero-monitoring.

Practical

Outline of a virology lab and guidelines to work in a virology lab. Processing of clinical specimens for isolation of viruses. Cultivation of viruses in cell cultures and embryonated eggs. Harvesting of virus. Study of cytopathic effects. Titration of virus and estimation of TCID50. Haemagglutination and haemagglutination inhibition test. Detection of virus by SNT, AGID and ELISA.

Suggested Reading

1. Maclachlan NJ and Dubovi EJ, 2016, Fenner's Veterinary Virology, 5th edn, Elsevier.

Embryo Transfer Technologies 3 (2+1)

Objectives

1. To study the veterinary reproductive technologies used to obtain offspring from animals as an alternative to natural mating

2. To study the techniques in embryo transfer
3. To study gene transfer and biopharming in conjunction with embryo transfer

Theory

History, advantages, limitations and scope of embryo transfer technology. Estrus cycle and its detection in animals. Methodology of superovulation. Ovum pick up (OPU). Preparation of sperm for in vitro fertilization (IVF). Embryo grading and culture. Micromanipulation and immuno-modulation for enhancement of fecundity.

Different methods of gene transfer and their limitations; embryo splitting; embryo sexing by different methods; production of transgenic livestock by nuclear transfer and its application. Animal Biopharming, animal gene bank; regulatory issues (social, ethical, religious and environmental). Cloning of domestic animals. Conservation of endangered species. Characterization of embryonic stem cells and applications.

Practical

Demonstration of estrus detection methods. Estrus synchronization. Superovulation. Oocyte collection from slaughterhouse ovaries. Grading of oocytes from slaughterhouse ovaries. Collection and preparation of semen samples. In vitro fertilization. Collection of embryos using non-surgical procedures. Grading and culture of embryos. Embryo sexing by different methods. Embryo splitting. Embryo freezing.

Suggested Reading

1. Gordon I, 2004, Reproductive Technologies in Farm Animals, CABI.
2. Hafez ESE, 2000, Reproduction in Farm Animals, Lippincott, Williams and Wilkins.

Animal Reproductive Biotechnology 3 (2+1)

Objectives

1. This course aims to study the basics of animal reproductive technologies used to analyse, understand and enhance the fertility of animals
2. To study male and female reproduction and methods of checking the quality of gametes
3. To study the direct and indirect methods of checking pregnancy

Theory

Follicle development, oogenesis, endocrinology of female reproduction, spermatogenesis, endocrinology of male reproduction, structure of spermatozoa and oocyte, semen: composition and contribution to semen by different accessory glands, capacitation of spermatozoa, acrosome reaction, estrus cycle, estrus detection.

Oocyte maturation analysis, methods of semen collection, semen analysis (morphological, microscopic, biochemical or molecular, computer assisted sperm analysis), semen extenders, cryopreservation of semen, oocytes and embryos (history and methods: slow, rapid/ vitrification), polyspermy. fertilization, embryo development, gastrulation, pregnancy diagnosis: different methods (direct and indirect).

Basic terms related to infertility, morphological abnormality in semen, male infertility: terms and causes (genetic and infectious), female infertility: terms and causes (genetic and infectious), artificial gametes, sex sorting of semen.

Practical

Semen collection by artificial vagina, semen analysis (color, volume etc., live dead staining, mass motility, progressive motility, concentration of semen, HOST, abnormality in semen, TUNEL assay, Free Radical Assay). Preparation of semen extender, calculation for semen doses preparation, semen doses preparation, oocyte Maturation assessment.

Suggested Reading

1. Dugwekar YG, 2006, Reproductive Biotechnology of Farm Animals, Agrotech Publishing Academy.
2. Hafez ESE and Hafez B, 2000, Reproduction in Farm Animals, 7th edn, Blackwell Publishing.
3. Y adav PS, Singh B, Singh I and Sethi RK, 2010, Reproductive Biotechnology in Buffalo, SSPH, ISBN: 8189304801.

Fundamentals of Molecular Pharming and Biopharmaceuticals 4 (3+1)

Objectives

1. To provide a basic understanding and principles of molecular pharming
2. To study various hosts and techniques for molecular pharming
3. To study the biopharmaceuticals that are successfully pharmed

Theory

Concept of molecular pharming and production of biopharmaceuticals. Mammalian cell culture manufacturing and microbial fermentation. Fermentation and cell culture processing. Protein purification and processing. Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.

Biopharmaceutical analytical techniques. Biopharma drug discovery and development; production of specific vaccines and therapeutic proteins, click chemistry/ bioorthogonal chemistry for application in plant science.

Practical

Isolation and purification of proteins from microbes and plants. Production of recombinant proteins in prokaryotes. Analysis of proteins by one and two-dimensional gel electrophoresis. Affinity chromatography. Immunoblotting. Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Suggested Reading

1. Brown TA, 2010, Gene Cloning and DNA Analysis: An Introduction, 6th edn, Wiley-Blackwell Publishing.
2. Kirkosyan A and Kaufman PB, 2009, Recent Advances in Plant Biotechnology, Springer.

3. Primrose SB and Twyman RM, 2013, Principles of Gene Manipulation and Genomics, John Wiley and Sons.

Microbial Biotechnology 4 (3+1)

Objectives

1. To study the scope and methods of using industrially useful microorganisms
2. To study the applications of microbes in industry and agriculture
3. To study the methods used for improving the microorganisms

Theory

Microbial biotechnology, scope and techniques. Industrially important microorganisms. Gene transfer mechanisms in microbes. Transformation, transduction, conjugation and recombination. Genetic variability in microorganisms. Biotechnological tools to improve the microbial strains with respect to industry and agriculture.

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues. Biotechnological treatment of wastewater, sewage and sludge. Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid), single-cell proteins. Recombinant and synthetic vaccines.

Practical

Isolation and preservation of industrially important microorganisms. Microbial fermentation, production of proteins and enzymes using bacteria, yeast and fungus. Microbial biomass production, utilization of plant biomass by recombinant microorganisms. Production of secondary metabolites from microbes.

Suggested Reading

1. Glaze AN and Nikaido H, 2007, Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd edn, Cambridge University Press.
2. Mohapatra PK, 2006, Text Book of Environmental Biotechnology, International Publishing House Pvt. Ltd.

Bioprospecting of Genes and Molecules 3 (3+0)

Objectives

1. To study the concepts of bioprospecting
2. To study the methods and techniques used for producing bioactive molecules
3. To study the IPR in relation to novel genes and molecules

Theory

Concepts and practices of bioprospecting. Traditional and modern bioprospecting. Gene prospecting. Isolation, synthesis and purification of new bioactive molecules; clinical and field trials; intellectual property rights and the legal framework. Patenting of new genes and/or novel biomolecules and their applications.

Principles of the Convention on Biological Diversity, biodiversity conservation and biotechnology. Development and management of biological, ecological, taxonomic, and related systematic information on living species and systems.

Bioprospecting of microorganisms and their components. Bioprospecting of biodiversity for new medicines. Identification and collection of material by random and traditional (medicinal) approaches. Screening for particular bio-activities. Elucidation of novel molecular form, process technology. Development of techniques for large scale industrial production of the bioactive product and developing market linkage.

Suggested Reading

1. Mohapatra PK, 2006. Text Book of Environmental Biotechnology, International Publishing House Pvt. Ltd.
2. Sharma PD, 2012, Ecology and Environment, 11th edn, Rastogi Publications.
3. Upadhyay SK and Singh SP, 2021, Bioprospecting of Plant Biodiversity for Industrial Molecules, ISBN: 978-1-119-71721-8.
4. Upadhyay SK and Singh SP, 2021, Bioprospecting of Microorganism-Based Industrial Molecules, John Wiley and Sons.

Molecular Ecology and Evolution 3 (3+0)

Objectives

1. To study the meaning and concepts of molecular evolution
2. To study the concepts of speciation and domestication in conjunction with evolution
3. To study the application of molecular tools for understanding molecular evolution

Theory

Molecular Evolution. Concept, molecular divergence and molecular clocks. Speciation and domestication. Evolution of earth and earlier life forms. Primitive organisms, their metabolic strategies and molecular coding. New approaches to taxonomical classification including ribotyping. Ribosomal RNA sequencing. Molecular tools in phylogeny, classification and identification.

Protein and nucleotide sequence analysis. Origin of new genes and proteins. Gene duplication and divergence. Genome evolution, components of genomes, whole genome duplications, chromosome rearrangements and repetitive sequence evolution.

Application of molecular genetics and genomics to ecology and evolution. Assessment of genetic diversity, phylogeny, inbreeding, quantitative traits using molecular tools. Mutations. Regulations of gene expression.

Suggested Reading

1. Beebee T and Rowe G, 2008, An Introduction to Molecular Ecology, 2nd edn, Oxford University Press.
2. Brown TA, 2007, Genome 3, Garlan Science Publishing.
3. Carvalho GR, 2002, Advances in Molecular Ecology, IOS Press Netherland.

Food Biotechnology 3 (2+1)

Objectives

1. To study the meaning and concepts of food biotechnology
2. To study the techniques in food processing and preservation
3. To study the application of microorganisms and genetic engineering in food biotechnology

Theory

Food Biotechnology. Introduction, history and importance. Applications of biotechnology in food processing; recent developments, risk factors and safety regulations. Food spoilage and preservation process. Food and beverage fermentation: alcoholic and non-alcoholic beverages, food additives and supplements.

Industrial use of microorganisms. Commercially exploited microbes: *Saccharomyces*, *Lactobacillus, Penicillium, Acetobactor, Bifidobacterium, Lactococcus* and *Streptococcus*; dairy fermentation and fermented products. Prebiotics and probiotics. Genetic engineering for food quality and shelf life improvement. Bioactive peptides. Labelling of GM foods.

Practical

Isolation, culture and maintenance of biotechnologically important micro-organisms. Use of laboratory and industrial scale shakers. Batch and continuous cultures. Use of fermentors. Detection of pathogens in food and feed. Detection of GM food. Visit to the food processing industry.

Suggested Reading

1. Hui YH and Khachatourians GG, 1995. Food Biotechnology: Microorganisms, Wiley-VCH
2. Shetty K, Paliyath G, Pometto A and Levin RE, 2006, Food Biotechnology, 2nd edn, CRC Press.

Green Biotechnology 3 (2+1)

Objectives

1. To study the meaning and concepts of green biotechnology
2. To study the methods and products for better plant growth
3. To study carbon sequestration and other biosafety approaches for a better environment

Theory

Green biotechnology: definition, concept and implication. Bio-fertilizers and bio-pesticides. Plant growth promoting rhizobacteria. Production of biofuels, biodiesel and bioethanol. Biomass enhancement through biotechnological interventions. Generation of alternate fuels in plants. Identification and manipulation of micro-organisms for biodegradation of plastics and polymers. GMOs for bioremediation and phytoremediation, their roles. Strategies for detection and control of soil, air and water pollutants, circular economy-based resource utilization for biofuel generation.

Carbon sequestration; methanogenic microbes for methane reduction. Microbes for phytic acid degradation. Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency. Marker-free transgenic development

strategies. Development of disease-resistant and pest-resistant crops through biotechnological tools. Biotechnology and sustainable development: sustainable agriculture practices and biotechnology, biotechnological solutions for food security, biotechnology in the context of climate change mitigation and policy and regulatory aspects of green biotechnology.

Practical

Identification and efficiency assays of micro-organisms for biodegradation and bioremediation. Isolation of *Bacillus thuringiensis* and plant growth promoting rhizobacteria. Production of biofertilizers, biopesticides and biofuel. Assays for removal of oil spillage.

Suggested Reading

1. Kirkosyan A and Kaufman PB, 2009, Recent Advances in Plant Biotechnology, Springer.
2. Kumar A, 2004, Environmental Biotechnology, Daya Publishing House.
3. Murray DC, 2011, Green Biotechnology, Dominant Publishers and Distributors.

Programming in Bioinformatics 4 (2+2)

Objectives

1. To study the importance and essentials of programming in bioinformatics
2. To study the operating system, algorithms, languages and functions for bioinformatics with hands-on practical
3. To study programming language

Theory

Introduction: operating systems, programming concepts, algorithms, flow chart, programming languages, compiler and interpreter. Computer number format: decimal, binary, octal and hexadecimal.

C-Language: history, constant, variables and identifiers, character set, logical and relational operators, data input and output concepts. Decision making: if statement, if-else statement, for loop, while loop and do-while loop. Arrays and functions, file handling. Program related to arithmetic operations, arrays and file handling in C.

Practical

PERL-Language: introduction, variables, arrays, string, hash, subroutines, file handling, conditional blocks, loops string operators and manipulators, pattern matching and regular expressions in PERL; sequence handling in PERL demonstrating string, array and hash. Shell Programming: concepts and types of UNIX shell, Linux variables, if statements, control and iteration, arithmetic operations, concepts of awk, grep and sed; Sequence manipulations using shell scripting.

Suggested Reading

1. Balagurusamy E, 2008, Programming in ANSI C, Tata McGraw-Hill Education.
2. Christiansen T, Foy BD, Wall L and Orwant J, 2012, Programming Perl, 4th edn, O'Reilly Media.
3. Kanetkar Y, 2013, Let Us C, BPB Publications.
4. Tisdall J, 2003, Mastering Perl for Bioinformatics, O'Reilly Media.

Bioinformatics Tools and Biological Databases 3 (2+1)

Objectives

1. To study various tools of bioinformatics for sequence analysis
2. To study biological data, databases and their applications
3. To study algorithms and methods for bioinformatic analysis, and visualization of results

Theory

Introduction: biological data types, collection, classification schema of biological databases. Biological databases retrieval systems. Sequence and molecular file formats.

Biological databases: nucleotide database, protein database, structural database, genome databases, metabolic pathway database, literature database, chemical database, gene expression database, crop database with special reference to BTISNET databases.

Bioinformatics tools: concept of alignment, scoring matrices, alignment algorithms, heuristic methods, multiple sequence alignment, phylogenetic analysis, molecular visualization tools.

Practical

NCBI; Expasy: SwissProt; EBI; Search engines: ENTREZ and SRS; Perform local alignment using all BLAST variants. Multiple sequence alignment using ClustalW. T Coffee. phylogenetic analysis by PHYLIP. MEGA.

Suggested Reading

1. Baxevanis AD and Ouellette BFF, 2001, Bioinformatics: A practical guide to the analysis of genes and proteins, John Wiley and Sons.
2. Mount DW, 2001, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
3. Xiong J, 2006, Essential Bioinformatics, Cambridge University Press.

Structural Bioinformatics 3 (2+1)

Objectives

1. To acquaint the students with the creation of new methods of analysing and manipulating biological macromolecular data in order to solve problems in biology and generate new knowledge
2. To study the analysis and prediction of the three-dimensional structure of biological macromolecules such as proteins, RNA, and DNA

Theory

Introduction to structural databases of macromolecules, natural and synthetic small molecules. Structure of amino acids. Protein structure classification, Ramachandran plot. Experimental structure determination methods. Motifs, domain, profiles, fingerprint and protein family databases.

Structural features of RNA, RNA secondary structure predictions. RNA folding. Small RNA prediction.

Structure prediction; basics of protein folding, protein folding problem, molecular chaperons. Secondary structure prediction methods and algorithms: homology, ab initio and folding-based tertiary structure prediction. Structure validation tools, energy minimization techniques. Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM. Structure visualization and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramachandran Plot, structural visualization tools, tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDBviewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck. GROMAC. SANJIVNI. BHAGIRATH.

Suggested Reading

1. Allan H, 2008, Modeling for Beginners, Wiley.
2. Creighton TE, 1993, Proteins: Structures and Molecular Properties, W. H. Freeman.
3. Malcolm CA, and Laurie JH, 2007, Discovering Genomics, Proteomics and Bioinformatics, Benjamin Cummings.
4. Mount DW, 2001, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
5. Setubal J, and Meidanis J, 1997, Introduction to Computational Molecular Biology, PWS Publishing Company.

Pharmacogenomics 3 (2+1)

Objectives

1. The students are exposed to develop strategies for individualizing therapy for patients, to optimize outcomes through knowledge of human genome variability and its influence on drug response
2. To study the research on genes and medications which has advanced the understanding of the genetic basis of individual drug responses

Theory

Basic concepts of pharmacogenomics, clinical application and challenges in pharmacogenomics. Human Genome Project, genetic diseases, personalized medicine and pharmacogenomics necessity in drug designing. Prediction of structural changes among sequence variants and genetic analysis. Microsatellites for studying genetic variations. Drug databanks. Gene therapy.

Drug Design: study of important drug targets and their variations. Pharmacophore designing, prediction of ADME properties. Computational tool for toxicity prediction. SAR and QSAR techniques in drug designing. Drug receptor interactions. Structural-based drug design. Lipinski's rule in drug design.

Practical

Receptor-Ligand interactions, pharmacophore development. OSDD. DrugBank. PubChem. Molecular representation using SMILES. Chemsketch: 2D and 3D structure. Structure analyses using Chimera/VMD. Detection of the active site of proteins using various software; bioavailability using Mol inspiration. Docking using HEX and AUTODOCK.

Suggested Reading

1. Allan H, 2008, Modeling for Beginners, Wiley- Blackwell Publishing.
2. Gupta SP, 1996, Quantum Biology, New Age International Pvt. Ltd.
3. Holtje HD, Wolfgang S, Didier R, and Hans D, 2003, Molecular Modeling: Basic Principles and applications, Wiley-VCH.
4. Lisa B, 2014, Combinatorial Library Methods and Protocols, Humana Press.

Metabolomics and Systems Biology 4 (3+1)

Objectives

1. To comprehensively identify and quantify all endogenous and exogenous small molecule metabolites in a biological system in a high-throughput manner.
2. To study the model and discover emergent properties, properties of cells, tissues and organisms functioning as a system.

Theory

Introduction to metabolomics, metabolomic databases, metabolite architecture, metabolic footprinting, enzyme discovery, *E. coli* metabolomics, fungal exo-metabolome, and diagnostic biomarkers in metabolomics.

Introduction to systems biology, transcriptome analysis, simple synthetic networks, noise in gene expression, structure of biological networks, pathway architecture, applications of systems biology in the discovery of disease signatures, drug targeting and design, and metabolomics in systems biology.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss 2D PAGE, E-PCR. Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

Suggested Reading

1. Berg JM, Tymoczko JL and Stryer L, 2002, Biochemistry, 5th edn, W. H. Freeman and Company.
2. Fersht A, 1999, Structure and mechanism of protein science, W. H. Freeman and Company.
3. Klipp E, Herwig R, Kowald A, Wierling C and Lehrach H, 2006, Systems biology in practice, concepts, implementation and application, Wiley VCH.
4. Nielsen J, and Jewett MC, 2007, Metabolomics, A Powerful Tool in Systems Biolog, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-74718-5.
5. Tomita M, and Nishioka T, 2005, Metabolomics, The Frontier of Systems Biology, Springer-Vertag, ISBN 4-431-25121-9.
6. Vaidynathan S, Harrigan GG and Royston G, 2005, Metabolome analysis: Strategies for system biology, Springer
7. VD and Voet J, (Ed) Biochemistry, 3rd edn, John Wiley and Sons.

Computational Methods for Data Analysis 3 (2+1)

Objectives

1. To apply statistical analysis and technologies to data to find trends and solve problems
2. To introduce students to some of the key computational techniques used in modelling and simulation of real-world phenomena
3. To study the applications of computational methods in biology using sequence data

Theory

Introduction to UNIX/LINUX operating system. Knowledge discovery and data mining techniques. Machine learning and pattern recognition, hidden Markov models. Artificial neural networks, support vector machines.

Principal component analysis, ANOVA. AMOVA and different clustering methods. Gene prediction algorithms and phylogeny algorithms. Basics of R statistical package.

Practical

Gene prediction: FGENESH. R statistical package installation and configuration, GUI for R: R-commander, R Studio, RKWard. Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Suggested Reading

1. Gareth J, Daniela W, Trevor H, and Robert T, 2013, An Introduction to Statistical Learning: with Applications in R, Springer.
2. Mathur KS, 2010, Statistical Bioinformatics with R, Elsevier.

MOOCs/ONLINE COURSES (10 credits)

The students will register for online courses of 10 credit hours (as per UGC guidelines for online courses) as a partial requirement for the comprising one or more courses at the approved portals during the third and fourth years with prior approval from the Head of the institution.

DAIRY TECHNOLOGY

Course Curricula for Undergraduate Programme in Dairy Technology UG-Certificate (Dairy Technology) UG-Diploma (Dairy Technology) B. Tech. (Dairy Technology)

INTRODUCTION

The syllabus for undergraduate program in Dairy Technology has been restructured to fulfil the requirements of National Education Policy (NEP), which envisages to build strong foundation of theoretical understanding of the subject and give adequate hands on experience to the students to develop competence and confidence to successfully embark on their journey to professional life.

The restructured syllabus therefore has provision for skill enhancement modules and students will get opportunities to choose from a bouquet of offered modules to develop proficiency in practical aspects of the technology. Besides, there are opportunities for holistic improvement in their personality through Foundation course *(Deeksharambh)*. Students will also have liberty to choose limited number of online courses in areas such as art, humanities or modern technologies for broadening their vision.

The restructuring exercise for the common syllabus of the three identified programs viz., UG-Certificate (Dairy Technology), UG-Diploma (Dairy Technology) and B. Tech (Dairy Technology) has been carried out after consultations and incorporation of inputs from Deans' of Colleges offering UG courses. Many senior and young faculty members at different colleges involved in teaching these courses, alumni in the industry and other stakeholders have provided valuable inputs at various stages of the restructuring exercise.

HIGHLIGHTS

- The B. Tech. (Dairy Technology) program will be of 172 credit hours (physical) and 08 credit hours (online) spread over eight semesters.
- Adequate weightage has been given to skill development courses in the first two years, semesters I to IV. Students have been given flexibility and choice in selection of skill development courses from a bouquet of multiple 'SEC modules' offered in all the four semesters of the first two years.
- In the first year, after completing the course requirement of minimum 40 credits in both the semesters, there is compulsory provision of extra 10 credits in lieu of internship of 10 weeks duration through Industry placement/Industry exposure/ Hands-on-training with the Dairy/Food Industry in related domain to become eligible on exit for the award of UG Certificate in Dairy Technology in one of the three chosen areas.
- After completion of two years, an internship of 10 weeks is necessary for those exiting after two years to become eligible for the award of UG Diploma in Dairy Technology. Students will thus complete requirement of minimum 80 credits plus 10 weeks of Internship.
- These students are expected to acquire competency and confidence to not only become employable but also self motivated to start their own enterprise.
- More emphasis has been given to proper amalgamation of theory and practical to provide them in-depth knowledge of the B. Tech (Dairy Technology) syllabus.
- Students will also have the flexibility to complete these non-gradial elective courses of 08 credits spread over the entire four years of the UG Program. Students can select the online courses on varying topics of their interest ranging from advanced sciences, computing, data sciences, AI, machine learning to humanities. The course can be chosen from various online platforms available such as SWAYAM, edX, Coursera etc.
- In eighth semester of the degree program students will be offered Internship (Industrial training) of 20 credits. On successfully completing the four years degree requirement, the student will be awarded undergraduate degree B. Tech (Dairy Technology).

Entry and Exist Options

The entry and exit options for the UG program in Dairy Technology are shown in the Fig.1

- **Exit options after one and two years**

Dairy Technology

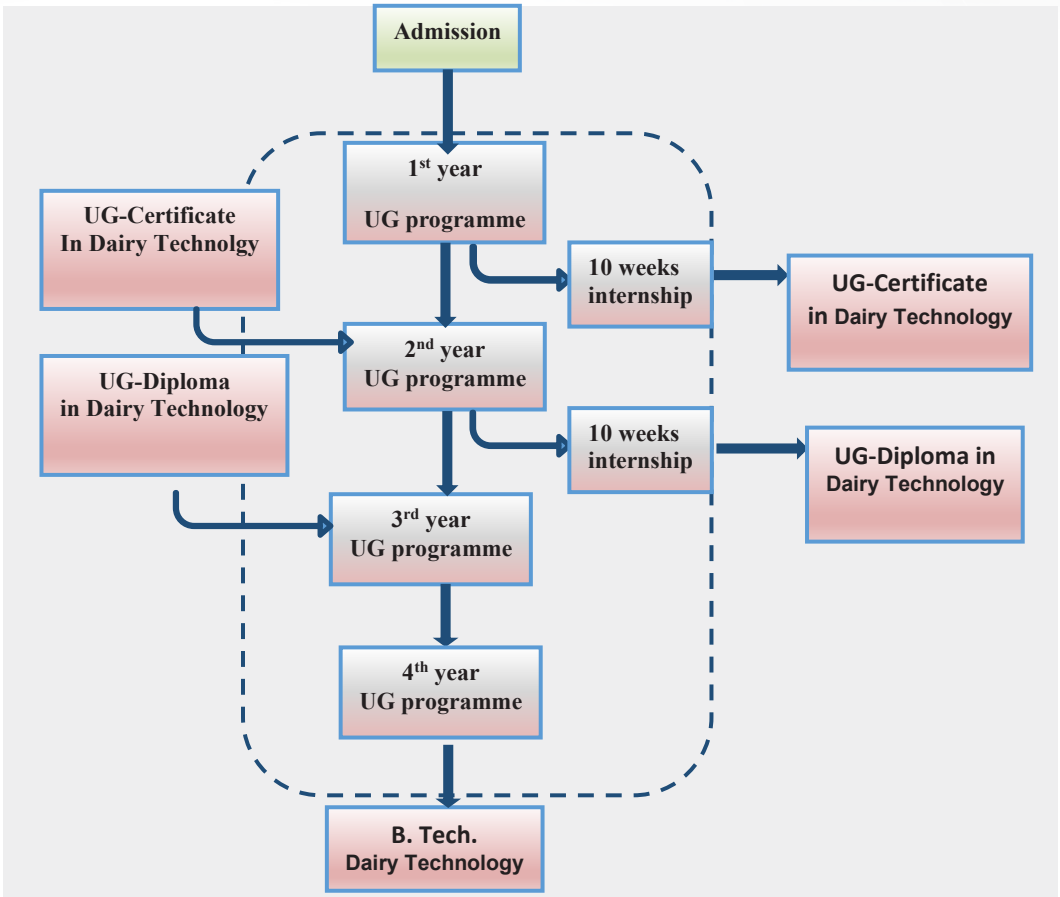

Fig.1 Entry and Exit options for the UG program in Dairy Technology

Exit options

1. **UG-Certificate (Dairy Technology)** (Exit after first year and completion of 10 weeks' internship)
2. **UG-Diploma (Dairy Technology)** (Exit after second year and completion of 10 weeks' internship)
3. **B.Tech. (Dairy Technology)** (On successful completion of four-year degree requirements)

UG- Certificate (Dairy Technology) in one of the following three areas- Exit after First Year and completion of 10 weeks' internship

- Dairy Products Processing
- Dairy Plant Maintenance
- Milk Quality Testing
- Admission mode–Common Entrance Test (National/ State/ University level) Eligibility: 10+2 Science with Mathematics as one of the subjects.

- The candidates having UG- Certificate (Dairy Technology) or UG- Diploma (Dairy Technology) will be allowed admission to the B. Tech (Dairy Technology) program in III semester or V semester, respectively.
- The students will register for a maximum of two modules of Skill Development Course/Skill for Employment and Entrepreneurship Development (SEC) during each semester in the first year. Thus, the name(s) of modules taken by the student will be reflected in the UG certificate award, such as UG-Certificate (Dairy Technology) in XXX (names of the modules).

ACADEMIC PROGRAMME

Semester-wise course distribution

S. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	Semester-I		
1.	*Deeksharambh* (Foundational two-week orientation course)	2 (0+2) NG	**22 (9+13) + 2 (Non-gradial)**
2.	Workshop Practice	2 (1+1)	
3.	Fluid Mechanics	2 (1+1)	
4.	Engineering Drawing	1 (0+1)	
5.	Fundamentals of Microbiology	2 (1+1)	
6.	Physical Chemistry of Milk	2 (1+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Communication Skills	2 (1+1)	
9.	Farming Based Livelihood System	3 (2+1)	
10.	NCC-I / NSS-I	1 (0+1)	
11.	****Skill Enhancement Course (SEC)- I	2 (0+2)	
12.	****Skill Enhancement Course (SEC)- II	2 (0+2)	
09 Credit for Core (Basic) Courses (2,3,4,5,6) 09 Credit for Common Courses: (7,8,9,10) 4 Credit for Skill Enhancement Course (SEC) (11&12)			
	Semester-II		
1.	Market Milk	4 (3+1)	**25 (13+12)**
2.	Heat & Mass Transfer	3 (2+1)	
3.	Basic Electrical Engineering	3 (2+1)	
4.	Microbiology of Fluid milk	2 (1+1)	
5.	Chemistry of Milk	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Personality Development	2 (1+1)	

S. No.	Course Title	Credit Hours	Total Credit hours
8.	NCC-II / NSS-II	1 (0+1)	
9.	****Skill Enhancement Course (SEC)-III	2 (0+2)	
10.	****Skill Enhancement Course (SEC)-IV	2 (0+2)	
15 Credit for Core (Basic) Courses (1, 2, 3, 4, 5) 6 Credit for Common Courses (6, 7, 8) 4 Credit for Skill Enhancement Course (SEC) (9 & 10)			
INT	Internship (10 weeks)	10 (0+10)*	**10 (0+10)***
Student taking various modules will get a Certificates with Nomenclature as follows-			
Nomenclature of Certificate			
Milk and Milk Products Processing			
Dairy Plant Maintenance			
Milk Quality Testing			
*Compulsory Internship for students exercising exit option (UG-Diploma) after I Year			
Second year			
Semester-III			
1.	Thermodynamics	3 (2+1)	**21 (11+10)**
2.	Traditional Indian Dairy Products	3 (2+1)	
3.	Dairy Engineering	3 (2+1)	
4.	Refrigeration & Air-conditioning	3 (2+1)	
5.	Starter Culture and Fermented Dairy Products	2 (1+1)	
6.	Physical Education, First Aid, Yoga Practices, and Meditation	2 (0+2)	
7.	Agriculture Marketing & Trade	3 (2+1)	
8.	****Skill Enhancement Course (SEC)-V	2 (0+2)	
14 Credit for Core (Basic) Courses (1,2,3,4,5) 5 Credits for Common Courses (6 & 7) 2 Credit for Skill Enhancement Course (SEC) (8)			
Semester-IV			
1.	Cheese Technology	5 (3+2)	**22 (12+10)**
2.	Fat Rich Dairy Products	3 (2+1)	
3.	Ice-cream & Frozen Deserts	3 (2+1)	
4.	Chemistry of Dairy Products	2 (1+1)	
5.	Microbiology of Dairy Products	2 (1+1)	
6.	ICT in Dairy Industry	2 (1+1)	
7.	Entrepreneurship Development and Business Management	3 (2+1)	
8.	****Skill Enhancement Course(SEC)-VI	2 (0+2)	
17 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6) 3 Credits for Common Course (7) 2 Credit for Skill Enhancement Course (SEC) (8)			

S. No.	Course Title	Credit Hours	Total Credit hours
INT	Internship (10 weeks)	10 (0+10)**	**10 (0+10)****
**Compulsory Internship for students exercising exit option (UG-Diploma) after I Year			
Third Year			
Semester-V			
1.	Condensed & Dried Milks	4 (3+1)	**22 (15+7)**
2.	Dairy By-products Technology	3 (2+1)	
3.	Quality and Safety Monitoring in Dairy Industry	3 (2+1)	
4.	Chemical Quality Assurance	2 (1+1)	
5.	Instrumentation and Process Control	3 (2+1)	
6.	Dairy Process Engineering	3 (2+1)	
7.	Operations Research	2 (1+1)	
8.	Economic Analysis	2 (2+0)	
Study tour*		**2 (0+2) NG**	**2 (0+2) NG**
22 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8) **2 credit (Non gradial) for Study tour (10-12 days during semester break)**			
Semester-VI			
1.	Dairy Plant Management and Pollution Control	2 (1+1)	**20 (12+8)**
2.	Strength of Materials & Dairy Machine Design	3 (2+1)	
3.	Financial Management & Cost Accounting	3 (2+1)	
4.	Food and Industrial Microbiology	2 (1+1)	
5.	Packaging of Dairy Products	2 (1+1)	
6.	Food Technology - I	3 (2+1)	
7.	Food Chemistry	3 (2+1)	
8.	Energy Conservation and Management	2 (1+1)	
20 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8)			
Fourth Year			
Semester-VII			
1.	Food Engineering	3 (2+1)	**20**
2.	Dairy Plant Design and Layout	2 (1+1)	
3.	Food Technology-II	3 (2+1)	
4.	Sensory Evaluation of Dairy Products	2 (1+1)	
5.	Biochemistry and Human Nutrition	2 (1+1)	
6.	Elective Courses	8***	
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses should be opted to complete total 20 credits)			

Semester-VIII			
1	In-plant Training	One Semester (0+20)	**20 (0+20)**
Online Courses			
1	Online Courses	**08**	**08**

****SEC-I, SEC-II, SEC-III, SEC-IV, SEC-V and SEC-VI to be selected from the list of the basket available under SEC-II module.

Department/Section-wise Course Breakup

S. No.	Course Title	Credit hours	Total
Foundational courses (two week)			
	Deeksharambh	0+2 (NG)*	2 (0+2)
Common Courses			
MDC	Farming Based Livelihood System	3 (2+1)	09
	Agriculture Marketing & Trade	3 (2+1)	
	Entrepreneurship Development and Business Management	3 (2+1)	
VAC	Agricultural Informatics and Artificial Intelligence	3 (2+1)	06
	Environmental Studies and Disaster Management	3 (2+1)	
AEC	Communication Skills	2 (1+1)	08
	NSS/ NCC –I	1 (0+1)	
	Personality Development	2 (1+1)	
	NSS/ NCC – II	1 (0+1)	
	Physical Education, First Aid and Yoga Practices	2 (0+2)	
Department/ Section			
	Study Tour	2 (0+2) NG*	02

• Non- Gradial

Dairy Technology

Course category	Course title	Credit Hours
Core Courses	Market milk	4 (3+1)
	Traditional Dairy Products	3 (2+1)
	Fat Rich Dairy Products	3 (2+1)
	Condensed and Dried Milks	4 (3+1)
	Cheese Technology	5 (3+2)
	Ice Cream and Frozen Desserts	3 (2+1)
	Dairy By Products Technology	3 (2+1)
	Packaging of Dairy Products	2 (1+1)

Course category	Course title	Credit Hours
	Sensory Evaluation of Dairy Products	2 (1+1)
	Dairy Plant Management and Pollution Control	2 (1+1)
	Food Technology I	3 (2+1)
	Food Technology II	3 (2+1)
SEC modules****	Operation of dairy evaporators and dryers	2 (0+2)
	Operation of liquid milk processing system	2 (0+2)
	Operation of ice cream freezers, ice candy making unit and their packaging	2 (0+2)
	Packaging of milk and milk products	2 (0+2)
	Technology of heat and acid coagulated milk products	2 (0+2)
	Canning and Sterilization systems for Dairy and Food Applications	2 (0+2)
	Extrusion Processing in Dairy and Food Industry	2 (0+2)
	Calibration of Dairy Equipments/Instrument	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Engineering

Course category	Course title	Credit Hours
Core Courses	Workshop Practice	2 (1+1)
	Fluid Mechanics	3(2+1)
	Engineering Drawing	1(0+1)
	Thermodynamics	3 (2+1)
	Heat and Mass Transfer	3 (2+1)
	Basic Electrical Engineering	3 (2+1)
	Refrigeration and Air conditioning	3 (2+1)
	Dairy Engineering	3 (2+1)
	Dairy Process Engineering	3 (2+1)
	Instrumentation and Process Control	3 (2+1)
	Food Engineering	3 (2+1)
	Strength of Materials and Dairy Machine Design	3 (2+1)
	Dairy Plant Design and Layout	2 (1+1)
	Energy Conservation and Management	2 (1+1)
SEC modules****	Electrical Power supply and distribution in Dairy plant	2 (0+2)
	Introduction to AutoCAD/Solids works, Ansys, CFD for Design of Dairy machines and Layout	2 (0+2)
	Electrical and Control Systems in Dairy Plant	2 (0+2)
	Design, Operation and Maintenance of Cold Storage, Ice Bank tanks, Ice silo and refrigeration plant in Dairy plant	2 (0+2)

Course category	Course title	Credit Hours
	Capacity Design, operation and Maintenance of steam Boilers, Air compressor, DG set, Soft water plant, and other utilities in Dairy plant	2 (0+2)
	Hygiene and Safety Engineering	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Chemistry

Course category	Course title	Credit Hours
Core Courses	Biochemistry and Human Nutrition	2 (1+1)
	Physical Chemistry of Milk	2 (1+1)
	Chemistry of Milk	3 (2+1)
	Chemistry of Dairy Products	2 (1+1)
	Chemical Quality Assurance	2 (1+1)
	Food Chemistry	3 (2+1)
SEC modules****	Basic aspects of milk and milk products testing	2 (0+2)
	Nutritional evaluation of milk and milk products	2 (0+2)
	Malpractices in dairy industry: detection & control	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Microbiology

Course category	Course title	Credit Hours
Core Courses	Fundamentals of Microbiology	2 (1+1)
	Microbiology of Fluid Milk	2 (1+1)
	Microbiology of Dairy Products	2 (1+1)
	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
	Starter Culture and Fermented Dairy Products	2 (1+1)
	Food and Industrial Microbiology	2 (1+1)
SEC modules****	Food safety and hygiene	2 (0+2)
	Preparation and management of starter cultures for fermented milk products	2 (0+2)
	Basic microbiological tests for quality of milk and milk products	2 (0+2)
	ISO 22000 : Food Safety Management System	2 (0+2)
	FSSAI rules and regulations	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)
	BIS certifications for the dairy industry	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Business Management

Course category	Course title	Credit Hours
Core Courses	Farming based Livelihood System	2 (1+1)
	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Environmental Science and Disaster Management	3 (2+1)
	Communication Skills	2 (1+1)
	Personality Development	2 (1+1)
	ICT in Dairy Industry	2 (1+1)
	Operations Research	2 (1+1)
	Economic Analysis	2 (2+0)
	Agriculture Marketing & Trade	3 (2+1)
	Entrepreneurship and Business Management	3 (2+1)
	Financial Management and Cost Accounting	3 (2+1)
SEC modules****	International dairy trade	2 (0+2)
	Brand awareness : Major dairy companies and their brands	2 (0+2)
	Understanding operations of a sweet shop	2 (0+2)
	Market Survey on dairy and related aspects	2 (0+2)
	Market research : tools and techniques	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major & minor/s)	:	117
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/Online courses	:	08
Total	:	**172 + 08****

The credits of *Deeksharambh* (0+2) and Study tour (0+2) have not been included in the total 180 credit hours.

Credits allocation scheme of UG Agricultural Engineering program is given in Table-1

TABLE: CREDITS ALLOCATION SCHEME OF B.TECH. (DAIRY TECHNOLOGY) (Credit Hours)

Table 1: Credits Allocation Scheme of B.Tech. (Dairy Technology) Program (Credit Hours)

Semester	Core Courses-(Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	09	3[2]	3[10]	1[3] + 2[4]	4	-	22	2[1]		
II	15	-	3[6]	1[3] + 2[7]	4	-	25	-	10[12]	
III	14	3[9]	-	2[8]	2	-	21			
IV	17	3[5]	-	----	2	-	22	-	10[13]	08
V	22	-	-	-	-	-	22	2[11]		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**117**	**9**	**6**	**8**	**12**	**20**	**172**	**4**		**08**

Note: The credit hours mentioned in the table includes both theory and practicals.

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks' duration).

[2] Farming Based Livelihood Systems

[3] NCC/NSS/NSO (I& II)

[4] Communication Skills

[5] Entrepreneurship Development and Business Management

[6] Environmental Studies and Disaster Management;

[7] Personality Development

[8] Physical Education, First Aid and Yoga Practices

[9] Agriculture Marketing & Trade

[10] Agricultural Informatics and Artificial Intelligence

[11] Study tour (10-14 days)

[12] Only for those opting for an exit with UG-Certificate

[13] Only for those opting for an exit with UG-Diploma

Detailed Syllabi

SEMESTER-I

Deeksharambh (NG 02 week) 2 (0+2)

The newly inducted students should be acclamatized with the campus and be given an orientation of the degree programme. The *Deeksharambh* will be a week-long foundation course. The foundation course should be a primer for the new comer students about the nature of the degree program, processes and procedures of academic activities and orientation to various facets of the university. The outline of the foundation course is to be decided by the university or constituent college and can broadly include:

- Help for cultural Integration of students from different backgrounds,

- Know about the operational framework of academic process in university
- Instilling life and social skills
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

1. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
2. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
3. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
4. Activities to enhance cultural Integration of students from different backgrounds
5. Field visits to related fields/ establishments
6. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Workshop Practice **2 (1+1)**

Objectives

1. Understanding the basic requirements of workshop activities
2. Description of various tools, equipment and processes used in various shops
3. Developing general machining skills involved in production of machine elements

Theory

Introduction: workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry. Heat treatment process: Hardening, tempering, annealing and normalizing etc.

Metal work: Metal cutting. Soldering, Brazing. Welding: Electric arc and Gas welding.

Smithy and forging operations: tools and equipment.

Bench work: The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing.

Introduction to following tool machines: (a) Lathe Machine, (b) Milling Machine, (C) Shaper and Planner, (d) Drilling and Boring machines, (e) Grinder, (f) CNC Machines etc.

Practical

To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of

carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools (lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

Suggested reading

1. Arora, R. P. Basic Mechanical Engineering. Charotar Publishing House Pvt. Ltd., Anand (Guj.).
2. Chapman, W.A.J. and Martin, S. J. 1998. Workshop Technology. Part-III. Viva Books Private Ltd, New Delhi.
3. Raghuvanshi, B. S. 2002. Workshop Technology. Vol. 2. Dhanpat Rai & Co. (P) Ltd, Delhi.

Fluid Mechanics 2 (1+1)

Objectives

1. Understand the properties of fluid at rest and in transit
2. Understand how fluids move in response to differences in pressure
3. Derive and apply general equations for various fluid flows
4. Working principles of pumps and evaluation of their performance

Theory

Units and dimensions, Properties of fluids. Compressible and non-compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gauges, Piezometer.

Fluid flow: Classification, steady uniform and non-uniform flow, Laminar and turbulent, continuity equation, Bernolli's theorem and its applications. Flow through pipes: Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity.

Flow through mouthpieces, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge.

Dimensional analysis: Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude.

Pumps: Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Pump selection and sizing.

Practical

Study of various types of pipes and pipe fittings. Study of different types of valves. Study of reciprocating pump. Study of rotary gear pump. Study of piezometer. Study of U tube Manometer. Study of inclined tube Manometer. Study of Venturimeter. Determination of frictional coefficient of given pipe. Determination of minor head loss. Study of Pitot tube. Study the construction and working principle of centrifugal pump. Study of Reciprocating pump. Study and measurement of flow of liquid by V- notch.

Suggested reading

1. Jain, A. K. (1995). Fluid Mechanics. 8th edn. Khanna Publishers, New Delhi.
2. Kumar, K. L. (1996). Engineering Fluid Mechanics. S. Chand & Co., New Delhi.
3. Kumar, D.S. (1998). Fluid Mechanics. S.K. Kataria and Sons, New Delhi.
4. Rajput, R.K. (1998). A Textbook of Fluid Mechanics. S. Chand & Co., New Delhi.

Engineering Drawing 1 (0+1)

Objectives

1. Knowledge about different types of lines, representation of letters and numbers in drawing sheet
2. Learn to draw projections of lines, planes and solids etc.
3. Understand and draw isometric projections
4. Learn to convert the isometric view to orthographic view and vice versa

Practical

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale.

Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of vivet heads, types of riveted; joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

Suggested reading

1. Bhatt, N. D. and Panchal, V. M. 2006. Engineering Drawing: Plane and Solid Geometry. Charotar Publ. House Pvt. Ltd., Anand.
2. Bhatt, N. D. and Panchal, V. M. 2004. Machine Drawing. Charotar Publ. House Pvt. Ltd., Anand.
3. Narayana, K. L., Kannaiah, P. and Reddy, K. V. 2011. Machine Drawing. New Age International Publ., New Delhi.
4. Reddy, K. V. 2010. Textbook of Engineering Drawing. B.S. Publ., Hyderabad.

Fundamentals of Microbiology 2 (1+1)

Objectives

1. Understand the structural and functional differences among microorganisms
2. Understand the different systems used to classify microorganisms
3. Explicate the principles of microbial growth, nutrient requirements, and growth control methods

4. Explore microbial diversity and their ecological roles
5. Comprehend the fundamentals of microbial genetics and host-microbe interactions

Theory

History of Microbiology: Discovery of microorganisms and microscopy (types, principles, and applications). Early Microbiologists: Contributions of Leeuwenhoek, Pasteur, Tyndall, Lister, Koch, Jenner, and Fleming. Scope of Microbiology: Applications in dairy, food, pharmaceutical, industrial, medical, and agricultural fields.

Classification of Microbes: Microbial Classification Systems: Traditional and numerical taxonomy. Classification Schemes: Whittaker›s five kingdoms and Woese›s three-domain system. Bacterial Classification: Berge's Manual of Systematic Bacteriology, phylogenetic trees. Prokaryotic vs. Eukaryotic Cells: Structure and function of prokaryotic cells. Cell Wall Differences: Gram-positive vs. Gram-negative bacteria; Archaeal cell walls.

Microbial growth and nutrition: Bacterial growth curve; factors affecting growth of bacteria, direct and indirect methods of measurement of bacterial growth; Bacteriostatic and bactericidal agents; Common nutrient requirements and nutritional types of microorganisms.

Microbial Ecology: Micro flora of air, soil, and water; extremophiles (archaea). Basics of Microbial Genetics and Host-Microbe interactions: DNA as the genetic material, Structure of DNA/RNA, Genetic code, Central Dogma, DNA replication, transcription and translation.

Practical

General instruction for microbiological laboratory. Microscope -- simple and compound; Microbiological equipment; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Preparation of commonly used growth media (liquid and solid): simple and differential media. Isolation techniques for microorganisms – Streak, spread and pour plate. Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN). Visit to Microbiology Laboratory of Dairy/Food Industry.

Suggested readings

1. Black, J. G., & Black, L. J. (2018). Microbiology: principles and explorations. John Wiley & Sons.
2. Pelczar, M. J., Chan, E. C. S., & Kriec, N. R. (2017). Microbiology. Mc Graw Hill Education.
3. Pommerville, Jeffrey C. (2021). Fundamentals of Microbiology, 12th eEdition**.** by Jeffrey C. Pommerville (2021).
4. Powar, C. B., & Daginawala, H. F. (2004). General microbiology. Himalaya Publishing House.
5. Tortora, G. J., Case, C. L., Bair III, W. B., Weber, D., & Funke, B. R. (2004). Microbiology: an introduction.
6. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2011). Prescott's microbiology (Vol. 7). New York: McGraw-Hill.

Physical Chemistry of Milk 2 (1+1)

Objectives

1. Learn about compositional difference in milk of different species and breeds of milch animals
2. Develop comprehensive understanding of physical properties of milk and their role in stabilizing milk system
3. Understand how temperature and concentration of milk affect physical properties of milk and impact its stability
4. Acquire knowledge about instrumental methods of measurement of different physical properties of milk

Theory

Constituents and gross composition of milk of different species and breeds of milch animals, Colloidal State: Distinction between true and colloidal solution, lypophilic and lypophobic solution, properties of colloidal system. Gels-their formation and properties, Milk as a colloidal system and its stability, Elementary idea about emulsion.

Density: Density and specific gravity, pyknometer method, hydrometer lactometer, Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk, viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Liquid State: Surface tension, surface energy interfacial tension, Surface tension of milk and the factors affecting it.

Refractive index, Colligative Properties of Dilute Solution: Vapour pressure, Raoults Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk, Osmosis and Osmotic pressure, Inter-relation of colligative properties, Electrical conductance of milk, Buffer solutions. Derivation of Henderson – Hasselbach equation and its application, buffer capacity and buffer index, milk as a buffer system, Equilibrium of electrolytes. pH indicators.

Oxidation- Reduction: Redox potential, Nernst equation, Redox system of milk, Occurrence of radio nuclide in milk and milk products, Molecular Spectroscopy: The spectrum of electro-magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscope.

Practical

Determination of density and specific gravity of milk using pyknometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

Suggested reading

1. Ling, E. R. 2008. A Textbook of Dairy Chemistry. J. V. Publ. House, New Delhi.
2. Mathur, M.P., Datta, R.D., and Dinakar, P. 2005. Textbook of Dairy Chemistry. Indian Council Agricultural Research Publ., New Delhi.
3. Noble P. Wong, Robert Jenness, Mark Keeney, Elmer H. Marth.1996. Fundamentals of Dairy Chemistry. 3rd edn, Springer New York, NY
4. Walstra, P., Jenness, R. and Badings, H. T. 1984. Dairy Chemistry and Physics. 1st edn. Wiley-Inter science, New York.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with agricultural-informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis,

automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Date, C. J. (2005). Database in depth: relational theory for practitioners. O'Reilly Media, Inc.
2. Dhabal Prasad Sethi and Manoranjan. Concepts and Techniques of Programming in C. Wiley India.
3. Education Solutions Limited, I. T. L. (2005). Introduction to Information Technology. India: Pearson Education.
4. Mahapatra, Subrat K Et al. Introductory Agri-Informatics. Jain Brothers Publication MN.
5. Rajaraman, V., and Adabala, N. (2014). Fundamentals of computers. PHI Learning Pvt. Ltd.

Communication Skills 2 (1+1)

Objectives

1. To acquire competence in oral, written and non-verbal communication
2. Develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele & Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication a Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

Farming Based Livelihood System 3 (2+1)

Objectives

1. To make the students aware about farming- based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems.

Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood.

Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry,

duckry etc.), Horticultural crops, Agro-forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large-enterprises including value chains and secondary enterprises as livelihood components for farmers,

Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country,

Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and program by Central and State Government.

Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises; Study of components of important farming based livelihood models/ systems in different agro-climatic zones; Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models; Field visit of innovative farming system models; Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors(Value Chain Models); Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis; Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7.
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4. Dixon, J. and Gulliver, A. Gulliver with D. Gibbon, D. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA.
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6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey, Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.

8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
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NCC-I **1 (0+1)**

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness program

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline; Drill- aim, general words of command, attention, stands at ease, stand easy and turning; Sizing, numbering, forming in three ranks, open and close order march, and dressing; Saluting at the halt, getting on parade, dismissing, and falling out.

Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march; Marking time, forward march, and halt. Changing step, formation of squad and squad drill; Command and control, organization, badges of rank, honors, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.

Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NSS-I **1 (0+1)**

Objective

- Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness program

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS;

Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.

Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.

Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.

Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

SEMESTER-II

Market Milk 4 (3+1)

Objectives

1. Learn about the salient features of the Indian and international dairy industry
2. Study procurement of milk and its reception in the processing plant
3. Learn homogenization, bactofugation and pasteurization of milk for retail distribution
4. Understand relevance and type of UHT plants, sterilization, processing induced changes in milk and aseptic packaging
5. Understand cleaning and sanitization practices followed in liquid milk processing plants

Theory

Dairy industry in India and abroad: Salient features. Collection and transportation of milk: (a) Organization of milk collection routes, (b) Practices for collection of milk, preservation at farm, refrigeration and natural microbial inhibitors.

Reception and treatment (pre-processing steps) of milk in the dairy plant: (a) Reception, chilling, clarification and storage: General practices, (b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) (c) Effect of homogenization on physical properties of milk, (d) Bactofugation: Theory and microbiology.

Thermal processing of milk: (a) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing, (b) Product control in market milk plant, (c) Defects

in market milk, (d) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized, vitaminised and sweet acidophilus milk, (e) Manufacture of sterilized milk, (f) Distribution systems for market milk.

UHT processing of milk**:** (a) Relevance of UHT processing in the tropical climate, (b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants, (c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems, (d) Technical control in the UHT plant, (e) Shelf life of UHT milk and tests for UHT milk.

Nutritive value of milk. Effect of heat processing on nutritive value. Cleaning and sanitization of dairy equipment.

Practical

Familiarization with equipment for reception of milk in plant; Pretreatments: Chilling, clarification, filtration; Standardization and numericals relating to it; Cream separation: parts of separator and the process; Operation of LTLT, HTST pasteurizer, laboratory steriliser; Preparation of special milks; toned, double toned, standardised, flavoured, sterilised; Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP; Detection of adulterants and preservatives in milk; Assessment of homogenisation efficiency in milk; Strength of common detergents and sanitizers used in market milk plant.

Suggested reading

1. Aneja, R.P. 1994. Dairying in India – A Success Story. Publication No. 1994/4. Asia Pacific Association of Agricultural Research Institutions (APAARI), Bangkok.
2. Banerjee, J.C. 2010. A Textbook of Animal Husbandry. Oxford and IBH Publishing Company Pvt. Ltd., Bombay
3. Cunningham, K.J. 2009. Rural and urban linkages: Operation Flood's role in India's dairy development. 37 pages. International Food Policy Research Institute (IFPRI) Discussion Paper 00924
4. Thompkinson, D.K. and Sabikhi, L. 2012. Quality Milk Production & Processing Technology. Xxvii+ 274 pp. New India Publishing Agency, New Delhi
5. www.fao.org/docrep/T3080T/t3080T07.htm
6. www.nddb.org/aboutnddb/operationflood.html

Heat and Mass 3 (2+1)

Objectives

1. Develop basic understanding of modes of heat transfer under steady and transient conditions
2. Acquire knowledge to apply basic principles of heat transfer to derive transfer co-efficients
3. Understand design and working of various heat transfer equipment
4. Acquire knowledge about basic concepts of mass transfer phenomenon and calculate mass transfer co-efficients

Theory

Basic heat transfer process: thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature.

One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines.

Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction.

Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient.

Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry.

Mass transfer: Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal diffusion. Mass transfer co-efficient and problems on mass transfer.

Practical

Determination of thermal conductivity: milk, solid dairy and food products. Determination of overall heat transfer co-efficient of: Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy and Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteurizer. Design problems on heat exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer Heat transfer in tubular heat exchanger: co current/ counter flow Heat transfer through composite wall. Heat transfer through legged pipes. Heat transfer through natural and forced convection.

Suggested reading

1. Domkundwar, S. (2008). A Course in Heat and Mass Transfer. Dhanpat Rai Publ., Delhi.
2. Eduardo Cao. (2010). Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
3. Green, Don W. Green and Robert H. Perry. (2008). Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Holman, J.P. Holman. (2010). Heat Transfer, 10th Ed. McGraw-Hill Book Co., Boston, USA.
5. Isachenko, V. P., Osipova, V. A. and Sukomel, A. S. (1977). Heat Transfer. Mir Publ., Moscow.

6. John H. Lienhard IV and John H. Lienhard V. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
7. Rajput, R. K. Rajput. (2008). Heat and Mass Transfer. S. Chand and Co., New Delhi
8. Semyonov, S. (1971). Fundamentals of Heat Transfer. Peace Publ., Moscow.
9. Semyonov, S. (1987). Problems in Heat and Mass Transfer. Mir Publ., Moscow.

Basic Electrical Engineering 3 (2+1)

Objectives

1. Learn about the basics of electrical circuits and networks
2. Understand the working, construction and characteristics of Electrical Motors
3. Develop understanding of operating principle and characteristics of DC machine and alternators
4. Acquire basic understanding of principles involved in power generation, transmission and distribution
5. Understand economics of electric power generation and its management

Theory

Alternating current fundamentals: Generation of alternating current or voltage, magnitude of induced E.M.F. Alternating current, R.M.S value and average value of an alternating current. Phase relation and vector representation. Cycle, Time period, Frequency, Amplitude, Phase and Phase Difference, Root – Mean Square Value, Average value, Form Factor, Crest or Amplitude Factor. Poly-phase Circuit: - Generation of Poly-phase Voltage, Phase Sequence, Interconnection of Three Phases such as Star Connection and Delta Connection and their respective value of current and voltages, Energy Measurement by using Single and Two Watt-meters.

Transformers: Working Principle of Transformer, Construction features of Core and Shell type transformer, Elementary theory of an Ideal Transformer, E.M.F. Equation of a Transformer, Vector diagram of transformer with and without load, Transformer losses, voltage regulation and efficiency of transformer, Construction and working on an Single Auto-transformer, Different parts of a 11/0.4 KV, Distribution Transformer.

Three Phase Induction Motor: Fundamental working principles, Production of rotating magnetic fields, construction, Different types of Rotor such as Squirrel Cage and Phase wound rotors, starting of induction motors using Direct on Line (DOL) and Star-Delta Starter. Soft starter and variable frequency drives.

Single Phase Induction Motors: Introduction, Different types of single phase induction motors such as Split Phase, Capacitor type, Shaded Pole type, Universal or AC series motors, Repulsion start induction run motor, Repulsion – induction motor.

DC Machine: Construction and operation of DC generator, types of generators and their various characteristics. DC motors: Torque speed characteristics of DC motors, Starting and speed control of DC motors by using 3-point DC Starter.

Alternators: Elementary working principles, Different parts of an Alternators, Relation between Speed and Frequency, E.M.F. equation in an Alternators. Different types of Circuit Breaker and its use. Introduction to DG set system.

Electric Power Economics: Economics of Generation of electrical energy and related important terms such as, load curve, connected load, Maximum Demand, Demand Factor, Average load or demand, Load Factor, Diversity factor and its significance, Capacity Factor or Plant factor, Utilization Factor, Plant Operating Factor and Selection of Units and related numerical, Various types of Tariff used for calculation of electricity bill.

Lighting system: Introduction to industrial lighting system. Energy Management and Power Factor Corrections: Types of energy, Energy Management, Concept of Energy Audit. Concept of Power Factor, Disadvantages of low power factor, causes of low power factor, Various methods of improving low power factor, Location of power factor correction equipment, Advantages of power factor improvement.

Practical

Introduction to various basic circuits of parallel wiring, stair case wiring, fluorescent light fitting; Study of voltage and current relationship in case of Star connected load; Study of voltage and current relationship in case of Delta connected load; Measurement of power in 3-phase circuit; for a balanced load, using watt meters. Measurement of power in 3-phase circuit; for a unbalanced load, using watt meters. Measurement of iron losses of Single Phase transformer by conducting open circuit test; Measurement of Copper losses of Single Phase transformer by conducting short circuit test. Starting and reversing the speed of a single phase induction motor; Starting and reversing the speed of a three phase induction motor using Direct on Line (DOL) Starter; Starting and reversing the speed of a three phase induction motor using manual Star Delta Starter; Starting and reversing the speed of a DC shunt motor using 3-point DC Starter; Starting of slip-ring induction motor by manual and automatic Slip-ring Induction Motor Starter; To determine the relation between induced armature voltage and speed of separately /self excited DC Shunt Generator.

Suggested reading

1. Anwani, M.L. and Anwani, I. (1972). Basic Electrical Engineering (I.T.I), Dhanpat Rai & Co. (P) Ltd., Delhi.
2. Gupta, J.B. (2010). Electrical Measurements and Measuring Instruments. S.K. Kataria & Sons, New Delhi.
3. Rajput, R.K. (2004). A Textbook of Electrical Technology. Laxmi Publ., New Delhi.
4. Rajput, R.K. (2007). Basics of Electrical and Electronics Engineering. Laxmi Publ., New Delhi.
5. Singh, S. (2005). Electrical Estimating and Costing, Dhanpat Rai & Co. (P) Ltd., Delhi.
6. Theraja, B. L. (1961). Fundamentals of Electrical Engineering and Electronics. S. Chand & Company Ltd., New Delhi.
7. Theraja, B.L. (1959). A Textbook of Electrical Technology. Vol. I & II. S. Chand & Co., Ltd., New Delhi.

Microbiology of Fluid Milk 2 (1+1)

Objectives

1. Learn about the types of microorganisms present in milk and sources of contamination
2. Study the types of microbial spoilage of milk and mechanisms of spoilage

3. Understand measures required for clean milk production and natural antimicrobial substances present in milk
4. Acquire knowledge about thermal processing of milk for enhancing quality and safety of milk
5. Learn about public health concerns arising out of microbial contaminants present in milk

Theory

Microbes associated with raw milk: Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their morphological and biochemical characteristics and classification. Significance of spore and spore-forming bacteria in milk, Microbial contaminants in raw milk, their sources during various stages of production - milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms; Microbiological changes in bulk refrigerated raw milk.

Concept of clean milk production: Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipment and dairy farm environment; Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoproxidase (LP) system. Somatic cells in raw milk: Significance and measurement.

Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavors and discolouration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health.

Microbiological aspects of fluid milk: Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal (pulsed field) micro-filteration, bactofugation, standardization and homogenization. Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk. Bio-film formation during processing and their control measures.

Public health aspects of fluid milk: Microbial zoonotic diseases transmitted through fluid milk; Milk borne diseases -food infection, intoxication and toxi- infection caused *E. coli, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Shigella species, Campylobacter* etc. Microbiological grading and legal standards of raw and processed milk.

Practical

Morphological examination of common dairy microorganisms (size and shape, arrangement and sporulation); Estimation of microbial load in raw milk by standard plate count (SPC) and dye reduction tests (MBRT, RRT); Grading of processed/ market milk by Aerobic plate count (APC), coliform and methylene blue reduction time; Enumeration of psychrotrophic, thermophillic, thermoduric and spore forming bacteria in raw and market milk; Detection of sources of contamination: Air, water, utensils, equipment and personnel, line testing; Spoilage of milk caused by microorganisms: souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discolouration; Detection of mastitis milks: pH, SLST, somatic cell count, chloride content, Hotis test and CAMP test. Detection and estimation of coliforms: presumptive, rapid coliform and IMViC Test.

Suggested reading

1. Britz, T.J. and Robinson, R.K. 2008. Advanced Dairy Science and Technology. 1st ed. Blackwell Publ. Ltd., UK.
2. Fernandes, R. 2009. Microbiology Handbook: Dairy Products. Royal Society of Chemistry, Revised ed., London.
3. Marth, E.H. and Steele, J. 2001. Applied Dairy Microbiology. 2nd ed. CRC Press, Boca Raton, USA.
4. Papademas, P. (Ed.). 2014. Dairy microbiology: a practical approach. CRC Press.
5. Prajapati, J.B and Behare, P.V. 2018. Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, New Delhi. ISBN: 978-81-7164-182-6.
6. Robinson, R.K. 2002. Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products. 3rd ed. Wiley-Interscience, New York.
7. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.

Chemistry of Milk 2 (1+1)

Objectives

1. Learn about the chemical constituents present in milk and factors affecting its composition
2. Develop understanding about different fractions of milk proteins, their properties, methods of estimation and genetic polymorphism
3. Acquire knowledge about milk carbohydrates, their properties and changes brought about by processing interventions
4. Learn about milk lipids, structure of glycerides and factors affecting fatty acids composition
5. Understanding of importance of minor milk constituents such as phospholipids, vitamin D and minerals present in milk

Theory

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins: α-Lactalbumin and β-Lactoglobuline. Properties of α-Lactalbumin and β-lactoglobulin, Immmunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins.

Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase.

Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re-arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose.

Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins.

Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

Practical

Sampling techniques of chemical examination of milk; Determination of pH and titratable acidity of milk; Determination of fat in milk by different methods; Determination of total solids and solids not fat in milk; Determination of total milk proteins by Kjeldahal method; Determination of casein, whey proteins and NPN in milk; Estimation of alkaline phosphatase and lipase in milk; Determination of lactose in milk; Determination of ash in milk; Determination of phosphorus and calcium in milk; Determination of chloride in milk; Determination of temporary and permanent hardness of water; Estimation of available chlorine from bleaching powder.

Suggested reading

1. Fox, P.F. (Ed). (1982). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
2. Fox, P.F. and Sweeny, Mc. (1998). Dairy Chemistry and Bio-Chemistry. Academic /Platinum Publ., NewYork.
3. Fox, P.F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
4. Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi.
5. Mathur, M.P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi.
6. Walstra, P. and Jenness, R. (1984). Dairy Chemistry and Physics. Wiley – Inter Sci. Publ., John Wiley and Sons, USA.
7. Webb, B. H., Johonson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

1. Understand different resources such as mineral resources, food resources, water resource, energy resources, natural resources and land resources
2. Gather knowledge about environmental pollution, soil pollution, air pollution and thermal pollution
3. Acquaint themselves with waste land reclamation, ecosystems and their management
4. Learn regarding biodiversity and its conservation, natural disaster and manmade disaster along with their management

Theory

Multidisciplinary nature of environmental studies; definition, scope and importance; Natural resources: renewable and non-renewable resources, natural resources and associated problems; Forest resources: use and over-exploitation, deforestation, case studies; Timber extraction, mining, dams and their effects on forest and tribal people; Water resources: use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems;

Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies; Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles; Ecosystems: concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of ecosystems as forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: introduction, definition, genetic, species and ecosystem diversity and biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Environmental pollution: definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution.

Social issues and the environment: from unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management.

Environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Dies, wasteland reclamation; Consumerism and waste products; Environment protection act; Air (prevention and control of pollution) act; Water (prevention and control of pollution) act; Wildlife protection act. Forest conservation act; Issues involved in enforcement of environmental legislation; Public awareness.

Human population and the environment: population growth, variation among nations, population explosion, family welfare programme; Environment and human health: human rights, value education, HIV/ aids; Women and child welfare; Role of IT in environment and human health.

Natural disasters- meaning and nature of natural disasters, their types and effects; Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

Man-made disasters- nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster management- effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community based organizations and media, Central, state, district and local administration; armed forces in disaster response; disaster response; police and other organizations.

Practical

Pollution case studies; Case studies- visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain; Visit to a local polluted siteurban/rural/industrial/agricultural; Study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.; Collection of polluted water/ effluent sample, sampling of polluted water/ effluents; Estimation of solids, pH, EC, DO, COD, BOD, Cl^-, F^-, CO_3^{2-}& HCO_3^-, Ca^{2+}& Mg^{2+}, K^+ and Na^+.

Suggested Reading

1. Anjaneyulu Y. 2004. Introduction to Environmental Science. BS Publications. Hyderabad.
2. Asthana D K and Asthana M. 2007. *Environment Problems and Solution*. S. Chand & Company, New Delhi.
3. Chauhan A S 2014. Environment Studies. Jain Brothers. Karol Bagh, New Delhi.
4. Dhaliwal G S and Kukal S S 2005. Essentials of Environment Science. Kalyani Publishers. Ludhiana.
5. Etherington J R. 1982. *Environment and Plant Ecology*. 2nd Edition. Wiley–Blackwell.
6. Kukal S S and Kingra P K 2019. Introduction to Environment and Disaster Management. Kalyani Publishers. Ludhiana.
7. Mahi G S and P K Kingra 2018. Fundamentals of Agrometeorology and Climate Change. Kalyani Publishers. New Delhi.
8. Saha A K. 2006. Text Book of Soil Physics. Kalyani Publishers. Ludhiana.
9. Sharma P D. 2010. Ecology and Environment. Rastogi Publishers. New Delhi.
10. Singh M P. 2004. *Environment and Pollution*. Anmol Publications Pvt Ltd.
11. Status of Forest Report 2019 Forest Survey of India. Dehradun.

Personality Development 2(1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution.

Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence-types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) Tata McGraw-Hill,
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development. 6th edn. Belmont, CA: Wadsworth.

NCC-II 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness program

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.

Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding:

Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

Introduction to map, scales, and conventional signs. Topographical forms and technical terms.

The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.

Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks.

Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- II **1 (0+1)**

Objective

- To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

  Practical/ Awareness program

Importance and role of youth leadership; Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies; Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations;

Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

SEMESTER-III

Thermodynamics **3 (2+1)**

Objectives

1. Acquire fundamental understanding of the principles of thermodynamics and heat transfer
2. Understand mathematical and practical aspects of heat transfer by conduction, convection and radiation
3. Develop understanding of thermodynamic properties of substances in gas and liquid states
4. Learn about the concept, type and working principle of different systems of internal combustion engines
5. Understand the classification, design and operation of steam generators

Theory

Importance and applications of thermodynamics in Dairy/Food processing. Basic concepts: Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of Thermodynamics.

Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. Analysis of non-flow and flow processes. The second

Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability.

Air Cycles: Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. I.C. Engines: Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines. Fuels.

Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. Properties of steam: Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption.

Steam generators: Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis.

Air Compressors: Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

Practical

A visit to dairy/ food processing plant showing the thermodynamics applications/ devices; Study of 2-stroke and 4-strokes IC engines working; Study of S.I. and C.I. engines working; Study of modern fuel injection systems of I.C. engines; Study of diesel fuel supply system (pump and fuel injector) of I.C. engine; Study of fuel supply system of a petrol engine; Study of cooling system of an I.C. engine (air cooling and water cooling); Study of lubrication system of I.C. engine; Study of Solar water heater and biogas plants and appliances; To study different types of boilers with the help of Lab models; To study Boiler mountings and steam-line layout and steam traps; Industrial exposure visit to plant with steam utilization; Study of Fire tube low pressure boiler installed in a dairy processing plant; Study of water softening plant installed with boiler in a dairy processing plant; Study the construction and working of Cochran boiler. Study of Babcok and Wilcox boiler. Study of different Boiler accessories.

Suggested reading

1. Arora, C.P. 1998. Thermodynamics. Tata McGraw- Hills Publ. Co., New Delhi.
2. Chattopadhyay P. Chattopadhyay 2000 Boiler Operation Engineering: Questions and Answers, McGraw-Hill
3. Steam Plant Operation 2017 Everett B. Woodruff, Herbert B. 2017. Steam Plant Operation. Lammers & Thomas F. Lammers. McGraw-Hill Education
4. Gupta, C.P. and Parkash, R. 1996. Engineering Thermodynamics. New Chand & Bros., Roorkie (UP).
5. Khurmi, R.S. and Gupta, J.K. 2004. A Textbook of Thermal Engineering. S. Chand & Co. Ltd., New Delhi.
6. Nag, P.K. Nag.2005. Engineering Thermodynamics, 3rd Ed. Tata-McGraw-Hill Education, New Delhi.

7. Rajput, R.K. Rajput. 2007. Engineering Thermodynamics, 3rd edn. Laxmi Publications (P) Ltd., Beangaluorue.
8. Smith, J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
9. STEAM/its generation and use 42nd edition. The Babcox and Willcox company.

Traditional Indian Dairy Products 3 (2+1)

Objectives

1. Understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
2. Learn about the chemical composition and legal standards for traditional Indian sweets
3. Acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
4. Learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milk-cake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.

Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process.

Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti Dahi: Product description method of manufacture and packaging process.

Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakand, Milk cake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, Misti Dahi, Chhana and Shrikhand; Visit to industry.

Suggested reading

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India
2. Agarwala, S.P. (2006). Equipment for paneer making, Lecture compendium on developments in traditional dairy products. Short course organized by CAS from Dec. 10-30, 2006: pp-132-137.
3. Dharam Pal and Narender Raju, P. (Eds). (2006). Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course, CAS in Dairy Technology, NDRI, Karnal.
4. Pal, D. (1997). Technology of the manufacture of rabri and basundi. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRl Deemed University, Karnal.

Dairy Engineering 3 (2+1)

Objectives

1. Learn about sanitary pipes and fittings and systems used for cleaning operations in dairy plants
2. Understand design and operation of various mechanical separations systems and devices used in the dairy industry
3. Acquire knowledge of design and operation of thermal processing systems such as pasteurizer, sterilizer and UHT processing plants
4. Learn about pouch filling and aseptic packaging machines for packaging of processed liquid milk

Theory

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes and fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system.

Mechanical Separation: Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers.

Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.

Thermal Processing: (a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, Arrhenius equation, D value, Z value, F value, Q_{10} value. (b) Factors affecting thermal destruction of microorganisms.

Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers.

Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance.

Mixing and agitation: Theory and purpose of mixing. Equipment used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

Practical

Study of S. S. pipes, fitting and gaskets; Study and selection of pump; Study of different types of milk filter; Study of equipment at raw milk reception dock; Constructional details, operation and maintenance of straight through can washer; Constructional details, operation and maintenance of C.I.P. system; Constructional details, operation and maintenance of homogenizers; Constructional details, operation and maintenance of batch pasteurizer; Constructional details, operation and maintenance of HTST pasteurizer; Comparison of conventional and modern pasteurizer; Constructional details, operation and maintenance of cream separators; Constructional details, operation and maintenance of sterilization systems; Constructional details, operation and maintenance of pouch filling machine; Constructional details, operation and maintenance of different types of agitators; Constructional details, operation and maintenance of bottle filling and capping machine; Visit to a dairy processing plant.

Suggested reading

1. Ahmad, T. 1985. Dairy Plant Systems Engineering. Kitab Mahal Publ., Allahabad.
2. Dairy Processing Handbook. 1995. Tetra Pak Processing Systems AB, Sweden.
3. Kessler. 1981. Food Engineering and Dairy Technology. V.A. Kessler Publ., Freising, Germany.
4. McCabe, W., Smith, J. and Harriott, P. 1993. Unit operations of Chemical Engineering. Mc-Graw Hill Inc. New York.
5. Towler, G. and Sinnott, R. 2008. Chemical Engineering Design. Elsevier, New York.

Refrigeration and Air Conditioning 3 (2+1)

Objectives

1. Understand the fundamental principles of refrigeration and air conditioning
2. Make comparative study of different refrigerants with respect to properties and applications
3. Learn to calculate the cooling/heating load for different applications
4. Understand the principle of psychometric processes and air conditioning
5. Design and implement refrigeration and air conditioning systems as per the recommended standards

Theory

Basic refrigeration cycles and concepts: Standard rating refrigerating machines; Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle; Departure from theoretical vapour compression cycle, representation on T-S and p-h diagrams; Mathematical analysis of vapour compression refrigeration system.

Refrigerants: Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, HFC, HCFC etc.); Brine, their properties and comparison. Multi-Pressure Refrigeration Systems: Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems.

Refrigeration Equipment and Controls: Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation.

Design and Balancing of Refrigeration System: Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis.

Cryogenic Freezing: Cryogenics, cryogens, properties, applications, cryogenic freezers. Psychrometry: Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls.

Air-conditioning Systems: Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. Cold Storage: Types of cold storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

Practical

Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools; Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler; Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant; Estimation of installed cooling capacity with the help of observed working pressures; Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT); Study of specifications, components, operation, control and maintenance of a Cold Storage; Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc.; Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications; Study of different types of capacity control devices used with compressors in a refrigeration plant; Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up (Comparison of actual and theoretical performance); Experimental study of a year-round air-conditioning system on an air-conditioning tutor or an experimental set-up; Determination of SHF and By-pass factor etc; Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor; Measurement of psychrometric

properties using psychrometric meters/gadgets; Industrial exposure visit to refrigeration/air-conditioning plant.

Suggested reading

1. Arora, S. C. and Domkundwar, S. 2018. A Course in Refrigeration and air conditioning. 5th ed. Dhanpat Rai and Sons, Delhi.
2. Arora, C. P. 2000. Refrigeration and air conditioning. Tata McGraw-Hill, New Delhi.
3. Ballaney, P. L. 1992. Refrigeration and air conditioning. Khanna Publ., New Delhi.
4. Jorden, R. C. and Priester, G. B. 1957. Refrigeration and air conditioning. Prentice-Hall, New Delhi.
5. Prashad, M. 2007. Refrigeration and air conditioning. New Age International, New Delhi.

Starter Culture and Fermented Dairy Products 2 (1+1)

Objectives

1. Understanding basic aspects of different types of starter cultures, their metabolism, storage and propagation
2. Understand preservation of starter cultures, tests for evaluating activity and purity as also factors affecting their survival and activities
3. Learn about the role of starter cultures in preparation of various fermented milk products and defects appearing as a result of improper starter activities
4. Acquire knowledge about cheese starter cultures and their role in development of desirable properties during processing and ripening

Theory

Types, metabolism and propagation of starter cultures: History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters; Probiotics and special cultures like exopolysaccharide, vitamin and low calorie sugar producing cultures; Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, factors affecting propagation; Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits. Prebiotic, postbiotic and symbiotic concepts.

Activity, Purity, Preservation of Starters and Starter Failure: Quality and activity tests for dairy starters and their preservation- methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation; Defects in starters and their control; Starter failures- effect of antibiotic residues, sanitizers and bacteriophages. Phages-life cycle, sources, prevention, chemical and mechanically protected systems for starter culture production.

Role of Starters in fermented milks: Role of starters in the preparation of various fermented milks; Types of fermented milks - dahi, yoghurt, acidophilus milk; different types of dahi and yoghurt; preparation; defects and their control. Kefir and koumiss: origin and characteristics; microbiology of kefir grains; Other fermented milks such as Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Microbiology of fermented milk products; their nutritional and therapeutic significance.

Chesse Starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant chymosin

Practical

Testing purity of starter cultures by gram's staining, catalase test; creatine test; Testing starter activity by dye reduction tests, Horrall-Elliker, White Head and Cox test; Preparation of single and mixed starter cultures; Evaluation of homo-fermentation and hetero-fermentation separately and in combination; Preservation of starter cultures by freeze-drying techniques; Preparation of concentrated starter (DVS); Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Preparation and microbial examination of dahi, *lassi*, *shrikhand*, yoghurt, cultured butter milk, acidophilus milk and kefir; Analysis of cheese for total spore and anaerobic spore count; Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening).

Suggested Readings

1. Bagchi, D., Lau, F.C. and Ghosh, D.K. (2010). Biotechnology in Functional Foods and Nutraceuticals. CRC Press LLC, USA.
2. Cogan, T.M. and Accolas, J.P. (1995). Dairy Starter Cultures. VCH Publ., USA.
3. Farnworth, E.R. (2008). Handbook of Fermented Functional Foods. 2nd edn. CRC Press, USA.
4. Full, R. and Perdigon, G. (2000). Probiotics – 1, 2, 3. Kluwer Academic Publ., Dordrecht, Netherlands.
5. Hutkins, R.W. (2006). Microbiology and Technology of Fermented Foods. Blackwell Publ. Professional, Iowa, USA.
6. Kosikowski, F.V. and Mistry, V.V. (2001). Cheese and Fermented Milks. Kosikowaski and Sons, Westport, CT.
7. Law, B.A. (1997). Microbiology and Biochemistry of Cheese and Fermented Milks. 2nd edn. Blackie, New York.
8. Prajapati, J. B and Behare, P. V. (2018). Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, New Delhi. ISBN: 978-81-7164-182-6.
9. Puniya, A.K. (2015). Fermented Milk & Dairy Products; CRC Press/ Taylor & Francis (ISBN 9781466577978); pp 1-714

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets

3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits and demerits.

Marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark).

Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs.

Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

SEMESTER-IV

Cheese Technology 5 (3+2)

Objectives

1. Learn about history of cheese making and evolution of different varieties of cheeses with distinctly different attributes
2. Understand how quality of milk and various additives play critical role in good cheese making
3. Acquire knowledge about the role of rennet and starter cultures in progression of chemical and biochemical processes responsible for desirable cheese quality attributes
4. Develop skills to manufacture good quality cheeses of both fresh and ripened varieties
5. Learn about new processing interventions for improving yield and accelerating ripening for improving economics of production of cheese

Theory

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese.

Milk quality in relation to cheese making. Pre-treatment of milk for cheese making; Physical and chemical additives and preservatives for cheese making. Rennet preparation and properties, milk clotting enzymes as rennet substitutes: plant, animal and microbial origin. Action of rennet on milk in relation to cheese making. Biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi soft, semi hard, hard, acid coagulated cheese.

Cheese starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; Manufacture of different choice-based varieties of cheese: Cheddar, Gouda, Swiss Mozzarella, Cottage, Cream and Quarg. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of

processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Practical

Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on cheese starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Familiarization with equipments, accessories and standardization numericals; Study of factors affecting rennet action; Determination of Rennet Cogaulation Time (RCT) of milk, Manufacture of Cheddar cheese; Manufacture of Gouda cheese; Manufacture of Mozzarella cheese; Manufacture of Swiss cheese; Manufacture of Cottage cheese; Manufacture of Processed cheese; Manufacture of Processed cheese spread; Manufacture of Processed cheese food.

Suggested reading

1. Cheese. (2010). A global strategic business report. Global Industry Analysts, Inc
2. Banks, J.M. (1998). The Technology of Dairy Products. 2nd edn. R. Early (Ed.), Chapman and Hall, Blackie Academic and Professional, London,
3. Kapoor, R. and Metzger, L. E. (2008). Process Cheese: Scientific and Technological Aspects—A Review. Comprehensive Reviews in Food Science and Food Safety. 7, 194-214.
4. Singh, S. (2011). Production and Marketing of Cheese – A Global Perspective. Lecture Compendium on Advances in Cheese and Fermented Products (Centre of Advanced Faculty Training), 1-8http://www.strategyr.com/Cheese_Market_Report.asp
5. Cheese (2017) Chemistry, Physics and Microbiology 4th ed Paul McSweeney, Paul Cotter, David Everett (Ed) Elsevier Publications, USA.
6. Patrick F. Fox, Timothy P. Guinee , Timothy M. Cogan , Paul L. H. McSweeney, (2018) Fundamentals of Cheese Science. Springer New York, NY.

Fat-Rich Dairy Products 3 (2+1)

Objectives

1. Understand manufacture of different types of creams, its packaging, marketing and quality control
2. Learn about the processes involved in making butter and spreads using batch and continuous methods, their packaging and quality
3. Learn ghee making methods, factors affecting its quality, packaging and legal standards required for marketing

Theory

Status of fat-rich dairy products in India and abroad. Cream: (a) Definition and Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. (b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. (c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT

processing of cream. (d) factors affecting quality of cream; ripening of cream. (e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: (a) Introduction to the butter making process; theory of churning, Legal standards. (b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine.

Special butters and related products: (a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. (b) Manufacture, packaging, storage and characteristics of margarine of different types.

Ghee and butter oil: (a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. (b) Ghee: Composition and changes during manufacture fat constants. (c) Butteroil: Manufacture of butteroil, packaging and storage.

Practical

Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

Suggested reading

1. Anantakrishnan, C.P. and Srinivasan, M.R.1964. Milk Products of India. ICAR Publications, New Delhi.
2. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. Technology of Indian Milk Products. A Dairy India Publication, Delhi.
3. De, S.1980. Outlines of Dairy Technology. Oxford University Press, Delhi.
4. Rangappa, K.S. and Acharya, K.T. 1974. Indian Dairy Products. Asia Publishing House, New Delhi.

Ice-Cream and Frozen Desserts 3 (2+1)

Objectives

1. Understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
2. Learn about design and working of Ice cream freezers including cleaning and sanitization
3. Aquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
4. Learn about the defects that appear in ice cream, causative factors and measures to control them

Theory

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts.

Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture.

Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant.

Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention.

Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Suggested reading

1. Arbuckle, W.S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut.
2. Hall, C.W. and Hedric, T.T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338
3. Hui, Y.H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley – VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
5. NDRI. 1998. Advances in Ice Cream and Frozen Desserts. Lecture compendium, Sixth short course, Dec15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.
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Chemistry of Dairy Products 3 (2+1)

Objectives

1. Acquire knowledge about composition and legal standards for different types of dairy products

2. Understand about the physico-chemical changes that take place during manufacture of dairy products as a function of processing variables
3. Learn about various deteriorative reactions that occur during storage of dairy products and measures to control them

Theory

Chemical composition and legal standards of milk products. Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants.

Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, Shrikhand.

Chemistry of cheese: milk clotting enzymes, enzymatic coagulation of milk, biochemical changes during ripening. Physico-chemical changes during preparation and storage of concentrated and dried milk products.

Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.

Practical

Cream: estimation of fat and acidity; Butter: estimation of fat, moisture, curd and salt content; Ghee: estimation of moisture, acid value, Butyro refractive reading and Reichert Meissl value / Polanske value; Determination of lactose and sucrose in sweetened condensed milk; Milk powder: moisture, fat, ash, solubility, acidity and bulk density; Ice cream: estimation of fat and total solids; Estimation of moisture, fat and salt content in cheese; Khoa/paneer: estimation of moisture and fat; Estimation of protein content in milk products and protein rich dairy products using Kjeldahl method.

Suggested reading

1. Fox, P. F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
2. Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi.
3. Mathur, M. P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi.
4. Megh R. Goyal, Suvartan G. Ranvir, Junaid Ahmad Malik. (2023). The Chemistry of Milk and Milk Products-Physicochemical Properties, Therapeutic Characteristics, And Processing Methods. AAP, CRC Press (Taylor & Francis Group).
5. Varnam, Jane and Sutherland, P. (2001) Milk and Milk Products: Technology, Chemistry and Microbiology. Springer Science & Business Media
6. Webb, B. H., Johonson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi.

Microbiology of Dairy Products 2 (1+1)

Objectives

1. To learn about entry of spoilage and pathogenic microorganisms vis-à-vis microenvironment of processed dairy products, their spoilage mechanism and preventive measures
2. Understand the type of microorganisms that could enter fat rich dairy products, condensed or dried milk, frozen and traditional dairy products
3. Learn about microenvironment of each of the dairy products and how they influence growth of these microorganisms which in turn cause spoilage
4. Understand critical processing factors that impact presence of different types of microorganisms and control measures to prevent spoilage and health hazards
5. Learn about microbial safety concerning to potential pathogens and their public health significance

Theory

Microbiology of Cream and Butter - Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/un-ripened cream), sterilized and UHT cream; Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. Fungal spoilage of Ghee.

Microbiology of Condensed, Evaporated and Dried products: Type of microorganisms associated with condensed and evaporated milk, their growth/ survival during manufacture and storage; Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/ bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk; pre-heating/DSI temperature and their impact on microflora of dried products.

Microbiological aspects of milk powder with respect to manufacturing steps and types of powder (heat classification of powders), Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. Microbiology of Infant Milk Formula (IMF).

Microbiology of Ice Cream and Frozen desserts: Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards.

Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfietc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Comparison of dairy sweets made at sweet shops vs. commercially manufactured sweets. Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards.

Practical

Microbiological examination of raw, pasteurized, sterilized and UHT cream for Standard plate count (SPC) as well as lipolytic and coliform counts, direct microscopic count (DMC), dye reduction tests and sterility test ; Microbiological examination of salted and unsalted butter for SPC, psychrotrophic, lipolytic, coliforms and yeast and mold count; K.Q test; Microbiological examination of concentrated milk for SPC, coliforms, spores, yeast and mold, thermoduric and thermophilic counts; Microbiological examination of dried milks for SPC, coliforms, *Staph. aureus*, *B. cereus, E. coli, Salmonella*, Sulphite reducing clostridia and Staphylococcal enterotoxins; Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms and Staphylococcal counts; Detection of *Salmonella* spp./*E. coli*; Microbiological examination of khoa for SPC, coliforms and staphylococcal counts besides yeast and mold counts; Microbiological examination of paneer and shrikhand for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts; Microbiological examination of Kheer for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts.

Suggested reading

1. Marth, E.M. and Steele, J.L. (1998). Applied Dairy Microbiology. Marcel Dekker, New York.
2. Marth, Elmer H. Marth and Steele, James Steele (2001) Applied Dairy Microbiology CRC Press
3. Palmiro, Poltronieri (2017) Microbiology in Dairy Processing: Challenges and Opportunities. John Wiley & Sons.
4. Prajapati, J.B and Behare, P.V. 2018. Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, NewDelhi. ISBN:978-81-7164-182-6.
5. Prajapati, J.B. (1995). Fundamental Dairy Microbiology, EktaPrakashan, Nadiad, India.
6. Robinson, R.K. (2002). Dairy Microbiology Handbook. John Wiley and Sons, Inc., New York.
7. Salminen, S. and Wright, A.V. (1998). Lactic Acid Bacteria. Marcel Dekker, New York.
8. Yadav, J.S., Grover, S. and Batish, V.K. (1993). A Comprehensive Dairy Microbiology. Metropolitan Publishers, New Delhi.

ICT in Dairy Industry 2 (1+1)

Objectives

1. Learn about computers and its operating environment for organizing, storage and retrieval of data
2. Understand application of computer as dairy management tools to describe, document and control all processes in the dairy industry
3. Learn about project management tools for project scheduling and monitoring for timely completion and implementation of information system
4. Develop competence in process modelling and simulation for product design and manufacturing to deliver good quality dairy products
5. Learn about newer applications of AI and Robotics in the dairy plant operations

Theory

Importance of Computerization and IT in dairy industries. Computers, Operating. Environments and Information Systems for various types of dairy Industries.

Principles of communication. Role of Computer in Optimization; Introduction to Operation. Research.

A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modelling and Simulation.

Introduction to SCADA and INTELUTION. CAD and CAM in Dairy Industries: Instrumentation, Process control, Inventory control, Automation, Robotics, Expert Systems and Artificial Intelligence, Instrumentation.

Practical

Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food. Chemical kinetics in dairy processing. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit and Vegetable processing unit. Familiarization with software related to dairy industry

Suggested reading

1. Balagurusamy, E. 2009. Fundamentals of Computers. Tata Mcgraw-Hill, New Delhi.
2. Britz, T. J. and Robinson, R. K. 2008. Advanced Dairy Science and Technology. Blackwell Publication, UK.
3. Elmasri, R. and Navathe, S. B. 2008. Fundamentals of Database Systems. 5th ed. Pearson Education, New Delhi.
4. Forouzan, B. A. 2012. Data Communication and Networking. 4th ed. Tata McGraw-Hill, India.
5. Goyal, D.P. 2000. Management Information Systems. 2nd ed. Macmillan Publishers, India.
6. Mishra, T.N. and Kirmani, M.M. 2004. System Analysis and Design. CyberTech Publishers, India.
7. Obrien, J. A., and Marakas, G. M. 2006. Management Information System. 7th ed. Tata McGraw-Hill, New Delhi.
8. Patterson, D.W. 2007. Introduction to Artificial Intelligence and Expert Systems. Prentice Hall, India.
9. Rajan, E.G. 2003. Information Technology. BS Publication, Hyderabad.
10. Rajaraman, V. 2002. Fundamentals of Computers. 3rd ed. Prentice Hall of India, New Delhi.
11. Shmulei, G., Patel, N. R. and Bruce, P. C. 2008. Data Mining for Business Intelligence. Wiley Interscience, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To expose the student to various aspects of establishment and management of a small business unit
2. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development.

Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities.

Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs; Visit to financial institutions and support agencies; Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Grover, Indu. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
4. Gupta C.B., 2001, Management Theory and Practice. Sultan Chand & Sons.
5. Khanka S.S., 1999, Entrepreneurial Development. S. Chand & Co.
6. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D., 1995, Effective Managerial Leadership. Deep & Deep Publ.
9. Singhal R.K., 2013, Entrepreneurship Development & Management, Katson Books.

10. Tripathi P. C. and Reddy P. N., 1991, Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

SEMESTER-V

Condensed and Dried Milk 4 (3+1)

Objective

- To learn manufacture of condensed milk and milk powders and understand factors affecting its quality as a function of raw milk quality and processing variables

Theory

Condensed milks: History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques; (a) Manufacture of evaporated milk including pilot sterilization test, (b) Manufacture of sweetened condensed milk, (c) Recombined sweetened condensed milk.

Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention. Recent advances with reference to freeze concentration and membrane concentration.

Dried milks**:** History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders.

Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk.

Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.

Practical

Manufacture of plain skim concentrated milk; Manufacture of Sweetened Condensed Milk; Manufacture of Evaporated Milk; Concentration of milk by membrane processing; Manufacturing of Skim Milk Powder by spray drying/roller drying; Manufacture of instant milk powder.

Suggested reading

1. Caric´, M. 1994. Concentrated and Dried Dairy Products. VCH, New York.
2. Coulter, S.T. and Jenness, R. 1973. Properties of dried milk products. In: W.B. van Arsdell et al., Eds., Food Dehydration, 2nd ed., Vol. 2, AVI, New York, pp. 290–346.
3. Fox, P.F. and McSweeney, P. 2003. Advanced Dairy Chemistry, Vol. 1, Proteins, 3rd ed., Kluwer Academic, New York.
4. Fox, P.F. and McSweeney, P. 2006. Advanced Dairy Chemistry, Vol. 2, Lipids. Birkhäuser, p 655.

5. Goff, D. 1995. Concentrated and Dried Dairy Products. Dairy Science and Technology Education Series. University of Guelph, Canada.
6. Hall, C.W. and Hedrick, T.I. 1971. Drying of Milk & Milk Products. AVI Publishing Co., Inc., Westport, Connecticut, USA.
7. Hanzikar, O.F. 1920. Condensed Milk and Milk Powder. 3rd ed. La Grange, Illinois, USA.
8. Heldman, D.R. and Lund, D.B. 1992. Handbook of Food Engineering, Dekker, New York.
9. International Dairy Federation Bulletins- Recombined Milks.
10. Karel, M. and D.B. Lund, 2003. Principles of Concentration and Drying of Foods: Physical Principles of Food Preservation. 2nd ed. Dekker, New York.
11. Masters, K. 1991. Spray Drying Handbook. 5th ed. Longman, Harlow.
12. Walstra, P. 2003. General aspects of water content and activity, and the effects on food properties and stability: Physical Chemistry of Foods, Dekker, New York.
13. http://www.niro.com/NIRO/

Dairy By-Product Technology 3 (2+1)

Objective

- To develop skills to process dairy byproducts to manufacture value added products

Theory

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems, Physico-chemical characteristics of whey, butter milk and ghee residue

By-products from skim milk: (a)Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. (b) Industrial and food uses of caseins (c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications. (d) Manufacture of casein hydrolysates and its industrial application. (e) Co-precipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications.

Whey processing: (a) Fermented products from whey, (b) Beverages from whey, (c) Deproteinized and demineralized whey, (d) Condensed whey, (e) Dried whey, types and their specification, manufacturing techniques, (f) Utilization of whey products. Application of membrane processing for whey processing.

Whey protein concentrates: (a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates, (b) Functional properties and food applications of WPC.

Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: (a) Condensed butter milk, (b) Dried butter milk, (c) Utilization of butter milk products.

Ghee residue: Composition, processing and utilization. Nutritional characteristics of by-products.

Practical

Manufacture of edible casein from cow and buffalo milk; Manufacture of rennet casein; Manufacture of sodium caseinate; Manufacture of calcium caseinate; Manufacture of co-precipitate; Isolation of whey proteins by cold precipitation technique; Manufacture of whey proteins, concentration by ultra filtration process; Manufacture of whey drinks; Manufacture of dried whey; Manufacture of lactose; Incorporation of whey protein concentrates in processed cheese foods; Manufacture of coffee whitener.

Suggested reading

1. Caric, M. 1994. Concentrated and Dried Dairy Products. VCH Publishers, Inc., New York.
2. Fox, P.F. (Ed.) .1992. Advanced Dairy Chemistry. Vol.1: Proteins, 3rd ed. Elsevier Applied Science, London.
3. Fox, P.F. and McSweeney, P.L.H. 2003. Advanced Dairy Chemistry. 3rd ed. Vol.1, part B. Kluwer Academic/Plenum Publishers, New York.
4. Gupta, V.K. and Mathur, B.N. 1989. Current trends in whey utilization. Indian Dairyman, 41: 165-169.
5. Gupta, V.K. 1997. Compendium of short course on "Technological advances in dairy by-products", NDRI, Karnal.
6. Gupta, V. K. 2007. Utilization of Whey. Monograph, Indian Dairy Association, New Delhi.
7. Gupta, V.K. 2008. Course compendium on "Technological advances in the utilization of dairy by-products". NDRI, Karnal.
8. Southward, C.R. 1985. Manufacture and application of edible casein products 1. Manufacture and properties. New Zealand Journal of Dairy Science and Technology, 20: 79-101.
9. Southward, C.R. and Goldman, A. 1975. Co-precipitates-A review. New Zealand Journal of Dairy Science & Technology, 10: 101-112.
10. Webb, B.H. and Whittier, E. O. 1970. By-products from Milk. 2nd ed. AVI Publishing Company, Inc., Westport (Connecticut), USA.
11. Zadow, J. G. 1992. Whey and Lactose Processing. Elsevier Applied Science, London.

Quality and Safety Monitoring in Dairy Industry 3 (2+1)

Objectives

1. Learn about the domestic and global food safety standards and regulations that are in place to ensure microbial safety of dairy foods
2. Develop understanding of principles and concept of food safety management system for adequately implementing strategy to control critical points and prevent hazard
3. Understand concepts of microbiological risk analysis and learn handling of dairy pathogens
4. Learn rapid enumeration techniques for indicator organisms critical from the perspective of plant and equipment hygiene

Theory

Concepts of Quality: Quality as defined by various authors and organizations, History of Quality, Seven tools of quality, Quality Assurance vs. Quality Control, Total Quality Management

(TQM); Concepts of Quality Management System (QMS)–ISO: 9001:2015; Principles of QMS; Standard requirements for QMS. Concept of Six sigma and lean sigma. Kaizen; Toyota Production System (TPS).

Global quality and food safety standards, Role and activities of International organizations involved in food regulation (CAC, WHO, FAO, INFOSAN, FDA, EFSA, ICMSF, GFSI, ISO etc.). Codex Alimentarius Commission (CAC): Working, History of CAC- GATT-Uruguay Round, WTO Regime, Sanitary and Phytosanitary (SPS) Standards, CAC in International food trade. National Organizations involved in food safety and quality (FSSAI, BIS, Agmark), FSSAI: Mandate, Role, Activities, Online services (FLRS, InFOLeT), Integrated food law, its main features and functions. Integrated food law of India (FSS 2006).

Food Safety: Good Manufacturing Practices (GMPs and cGMPs) and Good Hygienic Practices (GHPs); Pre-requisite programs (PRPs); HACCP: history, concept, principles and steps, with special reference to biological hazards in dairy foods, Concept of Food safety management system (FSMS)- ISO 22000:2018, principles and requirements; FSSC 22000; Comparison of ISO 22000 and FSSC 22000. Food safety auditing.

Microbiological Risk Analysis Concepts: Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria (Standards, Guidelines and Specifications), ICMSF two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant.

Tests and Microorganisms in process hygiene criteria and food safety criteria for dairy products as per FSSAI. Enumeration principles and procedure for conventional and rapid detection of predominant hygiene indicator organisms; Conventional and rapid techniques for isolation and identification of safety indicator organisms like *E. coli* (*E.coli*0157:H7), *Salmonella, Shigella, Bacillus cereus*, Sulphite reducing Clostridium and *Listeria monocytogenes*.

Plant and equipment hygiene: Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.

Practical

Conventional techniques for evaluation of milk and milk products for Hygiene and safety. Rapid detection of pathogenic bacteria based on antigen antibody principle: *Staphylococcal enterotoxins, E. coli* O157:H7*, Listeria monocytogenes* and *Salmonella* using VIDAS system; Rapid detection of total plate count, yeast and mold counts, Coliform, *E. coli*, Enterococci, Enterobacteriacae count using D-count and 3M Petrifilm kits; Preparation of GMP/GHP report; Designing of HACCP plan for milk products; Making of Decision Tree for Critical Control Point (CCP) determination; Prepration of audit report for ISO 9001 and ISO 22000; Evaluation of common sanitizing agents used in dairy plants by (a) suspension, (b) capacity test; Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods; Determination of BOD in dairy waste water.

Suggested reading

1. Bramley, A. J., McKinnon, C.H. 1990. The Microbiology of Raw Milk. In: Robinson, R.K. (Ed). Dairy Microbiology, Vol. 1., Elsevier Science Publishers, London.

2. Deeth, H. C., Datta, N. 2003 Heating systems - Ultrahigh temperature treatment (UHT). Encyclopedia of Dairy Sciences, Roginski, H., Fuquay, J.W., and Fox, (P.F. Eds). Elsevier Science Ltd, London, pp2642-2652.
3. Goff, H. D. 2003 Ice cream and frozen desserts - manufacture. Encyclopedia of Dairy Sciences. Roginski, H., Fuquay, J. W., and Fox, P. F. (Eds). Elsevier Science, London, pp1374-1380.
4. Hersom, A. C., Hulland, E. D. 1980. Canned Foods - Thermal Processing and Microbiology. Churchill Livingstone, Edinburgh.
5. Hinriches, J., Rademacher, B. 2003. Sterilization of milk and other products. Encyclopedia of Dairy Sciences. Roginski, H., Fuquay, J.W., and Fox, (P.F. Eds). Elsevier Science, London, pp. 2569-2577.
6. ICMSF [International Commission on Microbiological Specifications for Foods] .2002. Microorganisms in Foods 7: Microbiological testing in food safety management. Kluwer Academic/Plenum Publishers, New York.
7. ICMSF. 1998. Micro-organisms in Food 6: Microbial Ecology of Food Commodities. Blackie Academic & Professional, London.
8. ICMSF. 1998. Principles for the Establishment of Microbiological Food Safety objectives and related control measures. Food Control 9, 379-384.
9. ICMSF. 2002. Microorganisms in Foods 7. Microbiological testing in food safety management. Kluwer Academic / Plenum Publishers, New York, USA.
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12. Sutherland, B.J. (2003) Saltignfo cheese. Encyclopedia of dairy sciences. Elsevier Science, In: Roginski, H., Fuquay, J.W., and Fox, P.F. (Eds). London, pp. 293-300.
13. Varnam, A.H. and Sutherland, J.P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology, Vol. I, Food Products Series. Chapman and Hall, London.
14. Will, M. and Guenther, D. 2007. Food Quality and Safety Standards as required by EU Law and the Private Industry. A Practitioners' Reference Book. 2nd Edition. TechnischeZusammenarbeit (GTZ) GmbH. Postfach 5180, 65726 Eschborn, Germany.

Chemical Quality Assurance 2 (1+1)

Objectives

1. To understand regulatory framework, standards and test methods for ensuring chemical quality assurance of dairy products
2. Study national and global regulatory systems in place for ensuring chemical quality of milk and milk products
3. Learn about requirements for setting up of analytical laboratories and its accreditation
4. Develop skills for standardization of reagents and test procedures and calibration of glasswares for determination of quality parameters

5. Learn about possible chemical contaminants in milk and the test procedures to determine their presence in milk and milk products

Theory

Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc.

Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products.

Sampling procedures; labelling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer.

Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods.

Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf-life behavior of milk and milk products.

Practical

Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Detection of vegetable oils and animal body fat adulteration in ghee. Analysis of market samples of milk and milk products. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

Suggested reading

1. Alli, I. (2004). Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, USA.
2. Armit, E.G. (1975). Protein testing in the dairy laboratory. J. Soc. Dairy Technol., 28 (4) 189-191.
3. Biggs, D.A., Johnson. G. and Sjaunja, L.O. (1987). Analysis of fat, protein, lactose and total solids by infrared absorption. IDF Bull., No. 208, 21-29.
4. Day, R.A. and Underwood, A.L. (1977). Quantitative Analysis Laboratory Mannul. Prentice-Hall, New Delhi.
5. De, S. (1994). Outlines of Dairy Technology. Oxford University Press, New Delhi.
6. Desraj. (2007). Estimation major milk constituents using autoanalyser. Winter School on Instrumental Analysis of Dairy Food for Quality Standards, July 6th to July 26th, 2007, NDRI, Karnal.

7. Herschdoerfer, S.M. (2004). Quality Control in the Food Industry. Vol. I & II. Academic Press, London.
8. IDF. (1991). Residues and Contaminants in Milk and Milk Products. Special Issue. Int. Dairy Fed., Brussels.
9. IDF .(1991). Detection and confirmation of inhibitors in milk and milk products. IDF Bulletin No. 258.
10. IDF. (1997). Monograph on Residues and Contaminants in Milk and Milk Products. Special Issue. Int. Dairy Fed., Brussels.
11. Jacobs, M.B. (1999). Chemical Analysis of Food and Food Products. CBS Distributors, New Delhi.
12. Kilcast, D. and Subramaniam, P. (2000). The stability and shelf-life of food. Woodhead Publishing Ltd., Cambridge, England.
13. Kramer, A. and Twigg, B.A. (Eds) .(1966). Fundamentals of Quality Control for the food industry, The AVI Publ. Co., West Port, Conn., USA.
14. Rangappa, K.S and Achaya, K.T. (1974). "Indian Dairy Products". 2nd ed. Asia Publishing House, Mumbai.
15. Sen, D.C. and Roy, N.K. (1994). A Text Book of Practical Dairy Chemistry.
16. Van Resusel, A. and Klign, C.J. (1987). Automated methods for routine analysis of raw milk. The dye binding method for determination of the protein content of milk. IDF Bull No. 208, 17-20.

Instrumentation and process control 3 (2+1)

Objective

To study important instruments used in dairy processing operations and learn how to control the processes using these instruments

Theory

Importance of instrumentation and process automation in Dairy process control, Instrumentation scheme and characteristics: Introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems.

Sensors: Definition, principle of sensing and transduction, classification, selection and applications of Sensors. Types of Sensors, Measurement of parameters Proximity sensors: applications in Dairy processing operations, Digital and analogue signals, handling and processing, Piezo electric sensor: construction- working and applications, Micro, Nano sensors and smart sensors: Construction, characteristics and applications. Switches: Relays, solid state relay, Contactors etc, Micro and Limit switches: Types, construction, working and applications.

Electric Power Monitoring and control: Measurement and control of electric Power, digital AC/DC Volt, current, frequency PF meters. Voltage protection, Earth leakage, current protection, Phase reversal, phases monitoring relays. PF control relays, Smart Energy meters: Role and importance. Solid state alarm: working and application in dairy processing. Valve automation: Different types of automation valves and their application, Variable frequency drives (INVERTER): Importance, types, Construction, working and their application in Dairy process automation.

Speed control of DC motors. Digital Process timers: On-delay, Interval, cyclic, sequential, reverse-forward, star delta, totaliser and counter types of timers, their applications in control of dairy process operation. Micro-processor and Micro-controllers: Introduction and application.

Data acquisition and data loggers: Importance- and applications, Programmable logic controller: Introduction, importance, working- selection and applications, Communication Interfaces: RS-485, Rs-232, modbusetc, their role and applications, Programmable touch screen and HMI: Introduction, importance, working- selection and usage, SCADA: Introduction, importance, working- selection and usage.

Electronic Instruments: Role and importance of general purpose test instruments, Electronic Millimeter, Cathode Ray Oscilloscope, Measurement of amplitude, frequency and phase using CRO Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Display devices and recorders like X-Y and X-T recorders. Automation: Introduction to plant automation, automation hierarchy, PLC, SCADA.

Practical

Strain gauge characteristics and weight measurement; Measurement of pressure using bellows and diaphragm; Fabrication and calibration of thermocouples; Study the construction and working of Bourdon pressure gauge; Testing and calibration of pressure gauges using dead weight tester; Study the mechanism of pH meter and calibration; Study of proximity sensor; Study of different parts and working of pressure switch.

Study of RTD and Thermister; Study of different speed measurement sensor/ instruments; Study of LVDT; Measurement of level and flow using controllers; Temperature control using PID and On/Off controllers; Generation of wave signals using CRO, Data acquisition to PC from instruments using RS232/485 and USB interfaces, Fabrication of micro sensors and Study of PLC systems and Demonstration of PLC systems in Dairy Plant.

Suggested reading

1. Bela G, Liptak. 2003. Instrument Engineer's Handbook. Vol. I and II. 4th Ed. CRC Press. Boca Raton. FL, USA.
2. Doebelin, E.O. 2003. Measurement systems – Application and Design. Tata McGraw-Hill, New Delhi.
3. Don W, Green and Robert H, Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Gupta, J. B. 2003. A course in Electronic and Electrical Measurements. S. K. Kataria and Sons, New Delhi.
5. Johnson, C. D. 1977. Process control instrumentation technology. John Wiley & Sons. New York
6. Moorthy, D. V. S. 2003. Transducers and instrumentation. Prentice Hall of India Pvt. Ltd.
7. Rajput, R. K. 2006. Mechanical Measurements and Instrumentation. S. K. Kataria& Sons, New Delhi.
8. Theraja, B. L. 2008. A Text Book of Electrical Technology. S. Chand & Co., Ltd, Delhi.

Dairy Process Engineering 3 (2+1)

Objectives

1. To enable students understand working principles and design of equipments involved in concentration and drying of milk, mechanized manufacture of traditional Indian dairy products and packaging of milk
2. Learn about heat transfer, mass and energy balance and material transport involved in concentration and drying of milk
3. Understand design and operation of evaporators, dryers and fluidizers used for milk processing plants
4. Acquire knowledge of various membrane processing systems suitable for processing of milk and whey
5. Understand design and operation of packaging systems for milk, mechanized manufacture of Indigenous dairy products, frozen desserts and cheese

Theory

Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators.

Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems; Factors affecting bulk density of powder, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers.

Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers.

Processing equipment: Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipment; Packaging equipment: Packaging machines for milk and milk products.

Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

Practical

Constructional details, operation and maintenance of Vacuum pan; Constructional details, operation and maintenance of multiple effect evaporator; Constructional details, operation and maintenance of spray drier; Constructional details, operation and maintenance of butter making equipment; Constructional details, operation and maintenance of equipment related to ghee production; Constructional details, operation and maintenance of ice-cream making equipment; Constructional details, operation and maintenance of cheese making equipment; Constructional

details, operation and maintenance of reverse osmosis and ultra filtration system; Design problems on double effect evaporator and vacuum pan; Visit to a milk product plant.

Suggested reading

1. Ahmed, T. 1985. Dairy Plant System Engineering. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
2. Ahmed, T. 1990. Dairy Plant System Engineering and Management. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
3. Anantakrishnan, C.P. and Simha, N. N. 1987. Technology and Engineering of Dairy Plant Operations. Laxmi Publ., Delhi.
4. Brennan. 1969. Food Engineering Operations. Elsevier Publ. Co., Amsterdam, New York.
5. Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
6. Gardner, A. W. 1971. Industrial drying. Leonard Hill Publ., London.
7. Kesseler. 1981. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.
8. Masters, K. 1972. Spray drying: an introduction to principles, operational practice, and applications. Leonard Hill Publ., London.
9. Robinson, R. K. 1993. Modern Dairy Technology. Chapman & Hall, UK.
10. Spicer, A. 1974. Advances in Pre-concentration and Dehydration of Foods. John Wiley & Sons. New York.

Operations Research 2 (1+1)

Objective

To make students understand and analyse managerial problems and use optimization techniques to find solutions for using resources more effectively

Theory

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making; Modelling in Operation Research; Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems.

Inventory Control – Introduction and general notations, Economic lot size models with known demand; Replacement – Introduction, Replacement of items whose efficiency deteriorates with time.

Queuing – Introduction and general notions, Classification of queues and their problems, Probability distribution of queues; Various models in the queuing system; Sequencing – Statement of the problem, notations and assumptions, Problems with 'n' jobs and two machines; Generalization to 'm' machines.

Transportation model – Definition and application of transportation model, Formulation of transportation problems and their solutions; Assignment problems and their solutions.

Framework of PERT and CPM, Activities, events and network, PERT and activity time estimates, probability of project completion critical path analysis.

Practical

LP problems; Inventory Control problems; Replacement model problems; Problems on queuing theory, sequencing, transportation, assignment; PERT/CPM.

Suggested reading

1. Churchman, C.W., Ackoff R. L. and Arnoff, E.L. 1957. Introduction to Operations Research. John Wiley and Sons, New York.
2. Goel, B.S. and Mittal, S.K. 1974. Operations Research. Pragati Prakashan, Meerut.
3. Kapoor, V.K. and Kapoor, S. 2001. Operations Research Techniques for Management. Sultan Chand and Sons, New Delhi.
4. Sasieni, M.A., Yaspan and Friedman, L. 1959. Operations Research: Methods and Problems. John Wiley and Sons, New York.
5. Sharma, S.D. 1999. Operations Research. Kedar Nath Ram Nath & Co., Meerut.
6. Swarup, K., Gupta, P.K. and Mohan, M. 1989. Operations Research. Sultan Chand and Sons, New Delhi.
7. Taha, H. A. 2003. Operations Research. 7th edm. Pearson Education, New Delhi.
8. Taha, H.A. 2005. Operations Research: An Introduction. Prentice Hall of India Private Limited, New Delhi.
9. Wagner, H.M. 1982. Principles of Operations Research, with Applications to Management Decisions. Prentice Hall of India, New Delhi.

Economic Analysis 2 (2+0)

Objective

To equip students with the knowledge of analytical skills necessary to analyze economic phenomena, make informed decisions and apply economic principles to real-world situations

Theory

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors.

Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus.

Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns.

Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale.

Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition; National income – GDP, GNP, NNP, disposable personal Income, per capita income, inflation.

Suggested reading

1. Ghai, P. and Gupta, A. 2002. Microeconomics Theory and Applications. Sarup and Sons Publ., New Delhi.
2. Henderson, J.M. and Quandt, R.E. 2000. Microeconomic Theory: A Mathematical Approach. Mc-Graw Hill Kogakusha Ltd., Tokio.
3. Kreps, D.M. 1990. A Course in Microeconomic Theory. Princeton University Press, Princeton.
4. McAfee, R. P. and Johnson, J. S. 2005. Introduction to Economic Analysis.University Press Publ., Florida.
5. Rittenberg, L. and Tregarthen, T. 2009. Principles of Microeconomics. Flat World Knowledge, New York.
6. Samuelson, P. and Nordhaus, W. 2010. Economics. 17th edn. Tata Mc-Graw Hill, New Delhi.

SEMESTER-VI

Dairy Plant Management and Pollution Control 2(1+1)

Objective

The primary objective of the course is to provide students with comprehensive knowledge and skills related to the management of dairy processing operations and the effective control of pollution

Theory

Production Management: Definition, Function and structure of Production Management, Production planning and Control, Work study and measurement motion and time study; Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency.

Plant Operations Product and process control, Control charts, Process Sigma, Efficiency factors losses, Financial and Managerial efficiency; Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act and Regulations.

Human Resource Management: Personnel Management, Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions.

Safety hazards: hazards prevention, security for plant machinery and the employees, Plant Maintenance; Prevention and Break-down maintenance: Spare parts inventory, tools and lubricants, etc; Food hygiene: personnel hygiene, plant hygiene, water quality, etc.

Wastes discharged from dairy plants: An overview; Wastewater discharged from (a) Milk reception dock, (b) Liquid milk processing section, (c) Butter and ghee manufacturing, (d) Ice-cream and condensed milk manufacturing, e) Milk powder manufacturing, (f) Cheese and paneer manufacturing; Packaging wastes; CIP cleaning, Environmental issues in effluent discharge: (a) Effects on waterways, (b) Effects on land, (c) Effects on the atmosphere (d) Solid waste.

Waste treatment process in a dairy processing plant: Wastewater treatment options for A Dairy Processing Plant; Calculation of wastes discharged and the economics thereof.

Practical

Flow process charts of different milk products; Identification of steps of material losses on dairy plants; Identification of hazardous processes and equipment, (HACCPT plan) safety and precautions; Identification and uses of common lubricants; Waste characterization and Waste Utilization processes; Various treatments in waste disposal; Analysis of cleaning agents and sanitizers; Reports and records maintenance of dairy plant; Operational precautions; CIP cleaning.

Suggested reading

1. David, J. 2007. Contemporary Trends in Dairy Plant Management. Gyan Books Pvt. Ltd., Delhi
2. Kumar, H.D. 1998. Environmental Pollution and Waste Management. MD Publ. Pvt. Ltd., New Delhi.
3. Maliwal, G.L. 2007. Hand book of Environmental Management. Agrotech Publ. Academy, India.
4. Warner, J. N. 1976. Principles of Dairy Processing. John Wiley Publ., New York.

Strength of Materials and Dairy Machine Design 3 (2+1)

Objective

To enable students to analyze and design dairy machinery and related equipment

Theory

Strength of Materials: Basic concepts in Statics and Dynamics; Force Systems; Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem; Dynamics: Equation of motion.

Translation and rotation of a Rigid body, work and mechanics of materials: Stress-Axial Load Classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio: Shearing Stresses; Torsion, Torsion formula, Angle to Twist of circular members; Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams; Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads.

Dairy Machine Design: Procedures, Specification, strength, design factor, factor of safety selection of factor of safety; Materials and properties; Static strength, ductility, hardness, fatigue, designing for fatigue conditions; Theories of failure, Stresses in elementary machine parts, Design of a drive system; Design of length and thickness of belt.

Bearing: Journal and Anti-friction bearings; Selection of ball, tapered roller and thrust bearing; Springs, helical and leaf springs; Energy stored in springs; Design and selection of springs.

Practical

Design problems on applications of engineering statics and dynamics; Design problems on applications of work and energy; Design problems on applications of linear and angular momentum; Design problems on stress-strain diagram evaluation of elastic constants; Study on shear force and bending moment diagrams and its applications; Design problems on applications of flexural stresses; Design problems on applications of shearing stresses in beams; Study on system of limits, fits and tolerances and their applications; Design stresses in elementary machine parts; Design features and

applications of shafts; Design features and applications of axles; Design features and applications of keys; Design features and applications of couplings.

Design problems on various types of power transmission systems; Design features and applications of bearings; Design features and applications of springs; Design problems on agitator/ stirrer; Design features of milk silo.

Suggested reading

1. Adithan, M. and Bahl, R. Metrology Laboratory Manual. NITTTR, Chandigarh.
2. Bhandari, V. B. 2018. Design of Machine Element (Fourth Edition). McGraw Hill Education.
3. Hall Alfred. Machine Design. by Hall Alfred, McGraw Hill Pub.
4. Jain, R.K. Engineering Metrology by RK Jain. Khanna Publishers, New Delhi;
5. Kumar, S. Ravi. (2017). Principles of Dairy Machine Design. agrimoon.com
6. Rajput, R.K. Engineering Metrology. SK Kataria and Sons, Ludhiana.
7. Sharma, P. A Textbook of Machine Design. Kataria S. K. & Sons.
8. Sharma, P.C. A Text Book of Production Engineering. S Chand and Company, New Delhi.

Financial Management and Cost Accounting 3 (2+1)

Objective

To provide students with a foundational understanding of financial management principles, accounting systems and cost analysis methods

Theory

Introduction: Definition, scope and objectives of financial management; Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting; Doubles entry system of Book-Keeping; Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book; Preparation of Final Accounts and adjustments at the end of trading period; Preparation of Trial Balance Banking Transactions and Bank reconciliation statements; Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making.

Financial Analysis: Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis; Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis; Capital Structure: C;S Planning, risk return trade off, financial leverage; Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital and retained earnings, overall cost of capital.

Investment decision: Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Pay-back period method, Accounting rate of return method; Capital budgeting: Complex Investment Decisions: Investment timing and duration Investment decisions under inflation, Investment decisions under capital rationing.

Project Report; Feasibility Report Valuation; Working capital management- Concept and determinants of working capital, Estimating working capital needs; Depreciation – Concept and method; Introduction, Definition, Objectives, Common terms.

Costing: Essentials of sound costing system; Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium and Bonus Plans, Materials, Overheads.

Cost classification: Direct and Indirect expenses, fixed and variable costs; Various methods of apportioning indirect expenses; Inventory Management: Planning, control and costing; Stores and storekeeping, scope and importance, purchase procedure, types of purchase, location of stores and materials, procedure for the movement of stores, different methods of pricing materials, store records; Cost Sheets-Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations; Contract or Terminal costing; Process Costing: Process losses and inter-process profits, joint products and by products costing; Ascertainment of cost of milk production; Preparation of Cost Account Information for managerial decisions.

Practical

Preparation of Profit and Loss account; Preparation of Balance Sheet; Preparation of Cash flow statements; Preparation of Funds flow statements; Problems on Ratio analysis; Problems on Break-Even Analysis; Problems on Profit analysis; Problems on Operating Analysis; Problems on Financial leverage; Problems on Cost of Capital; Problems on Investment decisions; Problems on Capital budgeting.

Suggested reading

1. Bhattacharyya. 2007. Essential of Financial Accounting. S. Chand and Co., New Delhi.
2. Gupta, S.K. and Sharma, R.K.1996. Financial Management: Theory and Practice. Kalyani Publ., Ludhiana.
3. Khan, M.Y. and Jain, P. K. 2011. Financial Management: Text, Problems and Cases. Tata Mc Graw-Hill Publ., New Delhi.
4. Maheswari, S.N. 2010. Management Accounting and Financial Control. Sultan Chand and Sons, New Delhi.
5. Pandey, I.M. 1989. Financial Management. Vikas Publ., New Delhi.
6. Pandey, I.M. 2006. A Management Guide for Managing Company Funds and Profits. Tata Mc Graw-Hill Publ., New Delhi.
7. Reddy, P.N. and Appaniah, H.R. 1997. Essential of Management Accounting. Himalaya House, Bombay.
8. Shukla, M.C. and Grewal, T.S. 1979. Advanced Accounts. S. Chand and Co., New Delhi.

Food and Industrial Microbiology 2 (1+1)

Objective

The first part of the course deals with microbiological aspects of various food products including their spoilage and preservation technologies; The latter part deals with industrial fermentation and product manufacturing.

Theory

Scope of food microbiology: Basic aspects, history and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in different foods; Microbial Spoilage of foods: Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; Sources of contamination; Control of spoilage.

Food preservation: Principles of food preservation: physical methods, viz. low temperature and high temperature preservation (D, Z and F Values); Drying Methods; Chemical preservatives, Natural antimicrobial compounds and bio- preservation; Alternate methods of food preservation; Mode of action of various preservation methods on microbes.

Fermentation processes: Fermentation processes: Historical development, the range, components and types (i.e., submerged, surface and solid-state fermentation); criteria for selection of industrially important microorganisms; preservation and improvement of industrially important micro-organisms using metabolic engineering/genetic engineering; media for industrial process; upstream and downstream processing.

Types of fermenters: Fermenters: types (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis, estimation of biomass; difference in chemostat and turbidostat.

Microbial production of industrial products: Immobilization of enzymes/cells; Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine; organic acids (citric and lactic), enzymes (protease, lipase and rennet), vitamin (B_{12}), antibiotics and bacteriocins; and fermented whey beverages.

Practical

Microbiological examination of: (1) fresh and canned fruits, vegetables and juices; (2) flour and bread; and (3) eggs and meat; Isolation of psychrophilic, salt and sugar tolerant microorganisms from foods; Isolation of industrially important microorganisms from environment; Determination of Z, D and F values; Production and assaying of microbial enzymes (protease/ lipase); Production of lactic acid from whey; Production of nisin and assaying the antimicrobial activity of the culture; Design and control of a table-top and 10 liter lab fermenter (Demonstration); Production of ethyl alcohol from molasses and whey by yeasts; Production of fermented whey beverages; Educational tour to food processing/ fermentation industries.

Suggested reading

1. Adams, M.R. and Moss, M.O. 2002. Food Microbiology. 2nd edn. Panima publ., New Delhi.
2. Doyle, M.P., Beuchat, L.R. and Montville, T.J. (Ed.). 2001. Food Microbiology: Fundamentals and Frontiers. 2nd edn. ASM Press, Washington, D.C. USA.
3. Frazier, W.C. and Westhoff, D. C. 2004. Food Microbiology. 3rd edn. McGraw-Hill, New Delhi.
4. Jay, J. M. 1992. Modern Food Microbiology. 4th edn. Van Nostrand Reinhold, New York, USA.
5. Labuza, T.P., Fu, B., and Taoukis, P.S. 1992. Prediction of shelf life and safety of minimally processed CAP/MAP chilled foods: a review. J. Food Prot., 55,741.
6. Montville, T.J. and Matthews, K.R. 2005. Food Microbiology-An Introduction, ASM Press, Washington, D.C. USA.

7. Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Enfield: Science Publ., USA.
8. Puniya AK. 2015 Fermented Milk & Dairy Products. CRC Press /Taylor & Francis (ISBN-9781466577978). pp 1-714.
9. Ray, B. 2004, Fundamental Food Microbiology 3rd edn., CRC Press, Washington D.C. USA.
10. Reed, G. (Ed.).1987. Prescott and Dunn's Industrial Microbiology. 4th edn. CBS Publ., and Distributors, Delhi, India.
11. Waites, M. J. 2001. Industrial Microbiology: An Introduction. Blackwell Science, London.

Packaging of Dairy Products 2 (1+1)

Objective

To learn about the packaging materials and packaging systems available for milk and different types of milk products

Theory

Introduction, Importance of Packaging, History of Package Development, packaging materials, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information.

Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeats, concentrated and dried milks including baby foods; Packaging of functional dairy/food products.

Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages.

Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipment (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials.

Disposal of waste package materials, Packaging Systems; Hazards from packaging materials in food.

Practical

Identification of packaging materials, Flame Hot wire test, Testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength; Testing of glass bottle – resistance to thermal shock; Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance; Packaging of different dairy products by using prepack and vacuum packaging machines.

Suggested readings

1. Ahvenainen, R. (2003). Novel Food Packaging Techniques. Woodhead Publ. Ltd., Cambridge, England.

2. Bekker, M. (Ed.). (1986). Wiley Encyclopedia of Packaging Technology. John Wiley and Sons. New York.
3. Coles, R., Mc Dowell, D. and Kirwan, M. J. (2003). Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK.
4. Engineers India Research Institute. (2005). Handbook of Packaging Technology. EIRI, Delhi.
5. Han, J. (2005). Innovations in Food Packaging. Elsevier Science & Technology Books.
6. Hintlian, C. B. and Hotchkiss, J.H. (1986). The Safety of Modified Atmosphere Packaging: A Review, Food Technol. 40(12): 70–76.
7. Piringer, O. G. and Baner, A. L. (Ed.). (2008). Plastic Packaging: Interaction with Food and Pharmaceuticals. John Wiley and Sons, Weinheim, Germany.
8. Yam, K. L. (2009). Encyclopedia of Packaging Technology. 3rd edn. John Wiley and Sons, Inc. Publ., USA.

Food Technology-I **3 (2+1)**

Objective

To provide students with an in-depth understanding of food processing techniques as applied to fruits, vegetable and other plant based products

Theory

Harvesting, transportation and storage of fruits and vegetables; Post harvest processing of fruits and vegetables: Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables.

Juice processing: General steps in juice processing, role of enzymes in fruit; Juice extraction, equipment and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders; Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices.

Manufacture of Jam, Jelly and Marmalade: Role played by pectin, sugar and acid in jellied fruit products; Fruits and vegetable preserves, Glazed, Crystallized fruits; Tomato based products: Juice, puree, paste, sauce, ketchup; Pickles: Principle of pickling, technology of pickles.

Beverages: Classification, scope, carbonated non-alcoholic beverages and their manufacture; Fruit beverages and drinks, additives for fruit based beverages; Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee; Tea: Tea leaf processing, green, red, yellow, instant tea.

Technology of confectionery foods: Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products; Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products; Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

Practical

Manufacture of toffees and caramels, Testing the efficacy of blanching process; Drying of fruits and vegetables; Preparation of fruit-based drinks and beverages: Ready-to-serve drink,

Nectar, Squash, Whey-fruit based beverages; Manufacture of fruit jam; Manufacture of fruit jelly; Manufacture of chocolate confections; Manufacture of tomato ketchup/tomato sauce; Manufacture of soups; Manufacture of fruit preserve; Manufacture of candied fruits; Manufacture of fruit bar; Manufacture of pickles.

Suggested reading

1. Beckett, S. T. (1999). Industrial Chocolate, Manufacture and Use. Blackwell Science Ltd., Maldon, USA.
2. Edwards, W. P. (2000). The Science of Sugar Confectionery. The Royal Society of Chemistry, Cambridge, UK.
3. Er. B. Pantastico. (1975). Post Harvest physiology, handling, and utilization of tropical and sub-troipcal fruits and vegetables. AVI Publishing Co. Westport Conne.
4. Fellows, P. J. (2009). Food Processing Technology: Principles and Practice. 3rd Edition. CRC Woodhead Publishing, Boca Raton (USA).
5. Goldberg, Israel. (1994). Functional Foods: Designer Foods, Pharma Foods, Nutraceuticals. Aspen Publications, Maryland.
6. Hui, Y. H. (2006). Handbook of Food Science, Technology and Engineering. CRC Taylor & Francis Group, Boca Raton, FL, USA.
7. Jackson, E. B. (1990). Sugar Confectionery and Manufacture. Blackie and Son Ltd., Glasgow, NZ.
8. Laura A. de la Rosa, Emilio Alvarez-Passilla and Gustavo, A. Gonzalez-Aguilera. (2010). Fruits and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability. Willey Balckwell Publisher, Iowa (USA).
9. Somogyi, L.P., Ramaswamy, H. S. and Hui, Y. H. (1996). Processing Fruits: Science & Technology. Biology, Principles and applications, Vol.1. Technomic Publ. Co. Inc, Lancaster, USA.
10. Thompson, A. (2010). Controlled Atmosphere Storage of Fruits and Vegetables. 2nd Edition. CAB International, Oxfordshire, UK.
11. Vernam, A. H., and Sutherland, J. P. (1999). Beverages: Technology, Chemistry and Microbiology, Vol.2. Aspen Publ., Maryland.

Food Chemistry 3 (2+1)

Objective

To provide students with a comprehensive understanding of the chemical composition and properties of food systems and constituents

Theory

Water: Water binding and chemical reaction mediated by water; Food proteins: Classification and physico-chemical and structural properties; Lipids: Definition, classification of lipids, Unsaponifiable matter contents in various fats and oils, classification and chemical composition.

Carbohydrates: Classification of carbohydrates, polysaccharides, viz. linear, branched and modified; Properties and utilization of common polysaccharides, viz. cellulose, glycogen,

hemicelluloses, pectin; Food Enzymes: Hydrolases and lipases, utilization in food chemistry; Minerals in foods: Main elements, trace elements in eggs, cereals and cereal products, vegetables and fruits; Aroma compounds in foods: Threshold value, off-flavours.

Food additives: Vitamins and Amino acids, Minerals, Aroma Substances/flavour enhancers-Monosodium glutamate, 5-nucleotides sugar substitutes, sorbitol sweeteners- saccharin, and cyclamate, Food colours and food preservatives.

Antinutritional factors and Food contaminants: Toxic trace elements, radio nucleotides; Cereal and cereal products: Individual constituents like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making, influence of additives /minor ingredients on baking properties: physico-chemical changes during baking; Legumes: Classification, general composition and physico-chemical properties.

Vegetables and Fruits: Classification, general composition, chemical changes during ripening and storage; Jams, Jellies and Pickles: Classification, composition and preservation; Preservation of foods, general principles of food preservation.

Practical

Determination of moisture, acidity and gluten content in flour; Determination of total ash and acid insoluble ash in flour; Determination of starch in flour; Determination of total nitrogen in cereal products; Determination of acidity and vitamin C in citrus fruits; Analysis of tomato ketchup for total solids, acidity, ash and salt; Determination of total sugar in tomato ketchup; Determination of total ash and alkalinity of soluble ash in tea; Determination of water extractive in tea leaves. Determination of presence of Chicory in coffee powder; Determination of reducing sugars in Jam; Determination of iron in infant foods.

Suggested reading

1. Aurand, L. W. and Wood, A. E. (1973). Food Chemistry. The AVI Publishing Co., Connecticut.
2. Belitz, H. D., Grosch, W. and Schieberler, P. (2004). Food Chemistry. Springer, Berlin.
3. DeMan, J. M. (1999). Principles of Food Chemistry. A Chapman and Hall Food Science Book, Aspen Publ., Inc., Gaithersburg, Maryland.
4. Fennama, O. R. (ed). (1996). Food Chemistry. Marcel Dekker, Inc., New York.
5. Gopalan, C., Rama Sastri, B.V., and Balasubramaniam, S.C. (1991). Nutritive value of Indian Foods. National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR), Hyderabad.
6. Meyer, L. H. (1976). Food Chemistry. Reinhold Publ. Corporation, New York.
7. Potter, N. M. (1995). Food Science. The AVI Publishing Co., Connecticut.

Energy Conservation and Management 2 (1+1)

Objective

To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries

Theory

Introduction: Potential and Importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act 2003, Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution.

Energy balances and computation of efficiencies of equipment; Role of Energy inspectors and Auditors in energy management; Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques; Quality of power, Power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motor-selection and application, Energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls.

Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings.

Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors; Maintenance and upkeep of Vacuum lines and Compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment.

Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator.

Energy conservation in buildings: Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits.

Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries; Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of Energy Balance in Unit Operations and System boundaries; Solving examples on energy balances; Solving

problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve.

Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different BEE Star Ratings; Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Suggested reading

1. Ahmand, Tufail. 2012. Dairy Plant Engineering and Management. Kitab Mahal Publisher.
2. JiřiKlemeš, Robin Smith and Jin-Kuk Kim. 2008. Handbook of Water and Energy Management in Food Processing. A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition
3. Paul O'Callaghan. 1993. Energy Management, McGraw- Hill Book Company Europe, Shppenhangers Road, England.
4. Wang, Lijun. 2008. Energy Efficiency and Management in Food Processing Facilities. CRC Press Inc. 1st edn (4 December 2008). Taylor & Francis.

SEMESTER-VII

S. No.	Course Title	Credit Hours
1.	Food Engineering	3 (2+1)
2.	Dairy Plant Design and Layout	2 (1+1)
3.	Food Technology-II	3 (2+1)
4.	Sensory Evaluation of Dairy Products	2 (1+1)
5.	Biochemistry and Human Nutrition	2 (1+1)
6.	Elective Courses	**8*** **
	Total	**20**
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses should be opted to complete total 20 credits)		

Food Engineering 3 (2+1)

Objective

To provide a strong foundation in understanding the physical and mechanical properties of food and various unit operations in food processing.

Theory

Rheology: Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of

solids foods, Viscoelastic models; Measurement of food texture; Food Freezing: Thermal properties of frozen foods; Predication of freezing rates; Plank's equation, Design of food freezing equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods.

Food dehydration: Estimation of drying time for food products, constant rate period and falling rate period dehydration; Diffusion controlled falling rate period; Use of heat and mass balances in analysis of continuous dryers, Principle, construction working of vacuum drier, ring dryer, Flash dryer, fluid bed granulator, tunnel, Rotary dryer, solar dryer; Freeze concentration and dehydration: Heat and mass transfer, Calculation of drying time, Industrial freeze drying.

Other advance food processing operations and equipment: Equipment for fruit washing, pulping, fruit juice extraction, blanching, de-hulling, milling, Juice concentration, aroma recovery and distillation; Handling and storage of fresh produce like fruits and vegetables: Pre-cooling (Field heat removal), cleaning, grading, sorting, packaging and storage; Study of Stability chambers: Principle, construction and working.

Unit operations in Fruit and vegetable: Processing for production of puree and paste : Washing (Hydraulic flume Rotary washer, sorting and grading, size reduction, blanching, hot/cold break system, De-aerators, Pulpers, turbo extractors, forced circulation evaporators, Tube- in tube type sterilizer- Aseptic filler; Size reduction: Theory and principle, Different size reductions equipment; Unit operations and equipment for production of bakery products: Planetary mixer, sigma mixer, Rotary oven, etc. Unit operations in production of Coffee powder production: Mixer, roaster, size reduction plant, Extraction, concentration and spray drying unit; Rewet method of production of granulated coffee.

Meat and fish processing: Meat mincer, Marinator, sausage maker; Food extruder: Principle construction and working of Single and double screw extruder, Hot and cold extrude for production of ready eat and ready to cook foods.

Practical

To determine physical properties of food product; To determine rheological properties of food product; Determination of rheological parameters of solid and liquid foods by graphical solutions; To study food freezers; To study freeze drier; To determine drying characteristics of food product; To compare various dying methods; To determine juice yield; To compare hot water, steam and vacuum blanching; To study construction and working of aroma /distillation system; To study various size reduction equipment; Study of sifter for size separation; Study of planetary mixer/sigma mixer/ whisker etc; Study of grain mill; Study of microniser/colloid mill for homogenisation, emulsification of viscous products like tomato paste, mayonnaise etc; Visit to cold storage; Visit to food processing plant (bakery, coffee processing, meat processing, cereal processing).

Suggested reading

1. Brennan.1969. Food Engineering Operations. Elsevier Publ. Co., Amsterdam, New York.
2. Heldman, D. R. and Singh, R. P. 1981. Food Process Engineering, Avi Pub. Co., Westport, Connecticut.
3. Kesseler. 1981. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.
4. McCabe, W. L. and Smith, J.C. 2005. Unit Operations in Chemical Engineering. McGraw-Hill, New York.

5. Prasad, M. 2005. Refrigeration and Airconditioning. New Age International (P) Ltd., Publ., New Delhi.

Dairy Plant Design and Layout 2 (1+1)

Objective

To equip students with the knowledge and skills necessary to design and plan dairy processing plants efficiently and hygienically

Theory

Introduction of Dairy Plant design and layout: Type of dairies, perishable nature of milk, reception flexibility; Classification of dairy plants, Location of plant, location problems, selection of site; Hygienic design considerations for dairy processing plants;

Planning: Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout; Space requirements for dairy plants, estimation of service requirements including peak load consideration.

Dairy plant design aspects: General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design; Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop; Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility; Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout.

Building construction materials: Floors, general requirement of dairy floor finishes, floors for different section of dairy; Foundations, walls doors and windows.

Other design aspects: Drains and drain layout for small and large dairies; Ventilation, fly control, mold prevention, illumination in dairy plants; Computer aided Design: Introduction to CAD software.

Practical

Building symbols and convention; Symbols for equipment; Study of process schedule; To draw layout of collection/chilling centre; Visit to dairy processing plant for understanding of layout of different sections.

To draw layout of small dairy plant; To draw layout of small dairy plant using CAD; To draw layout of medium dairy plant; To draw layout of large dairy plant; To draw layout of cheese plant; To draw layout of ice-cream plant; To draw layout of butter manufacturing unit; To draw layout of ghee plant; To draw layout of composite dairy plant.

Suggested reading

1. Chander, L. 2004. Dairy Plant Layout and Design. Directorate of Information and Publ. of Agriculture ICAR.
2. Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
3. Hall, H. S. and Blombergsson, H. 1963. Milk Plant Layout. Food and Agriculture Organization Publ. United Nations.
4. Moore, J. M. 1962. Plant Layout & Design. Macmillan Publ., USA.

Food Technology 3 2+1)

Objective

To provide students with a understanding of the processing and technology involved in the production of various food products, with a focus on cereal grains, legumes, oilseeds, bakery and snack items, as well as meat, fish and egg products

Theory

Cereal grains, legumes and oilseeds: Structure and composition of cereals, legumes and oilseeds, milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour.

Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in manufacture of value added food products including malted milk foods.

Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates/ isolates, Utilization of oil cake in food formulation.

Bakery and Snack technology: Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti, Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips.

Meat, fish and egg technology: Development of meat, poultry, egg and fish industry in India, Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish;, Manufacturing process of dehydrated fish and fish pickles; Cleaning and sanitation, Waste management of food processing plants.

Practical

Manufacture of barley malt; Determination of cooking quality of rice; Manufacture of bread and bun; Manufacture of biscuits; Preparation of noodles; Preparation of cake; Manufacture of potato chips; Preparation of malt based food products; Manufacture of malted milk foods, Manufacture of soy beverage and tofu, Preparation of salami; Preparation of chicken soup; Manufacture of chicken pickle.

Suggested reading

1. Bamforth, C. W. and Barclay, A. H. (1993) Malting technology and the uses of malt. In: Barley: Chemistry and Technology, Alexander W. MacGregor and Rattan S. Bhatty (Eds.) pp. 297-354, American Association of Cereal Chemists, St. Paul, MN, USA.
2. Biscuit and Cracker Manufacturers Association (1981) Biscuit and Cracker Handbook, Washington, DC.
3. Chavan, J. K. and Kadam, S. S. (1989) Nutritional improvement of cereals by fermentation. CRC Crit. Rev. Food Sci. Technol., 28: 349-400.

4. Dhillon, L.S. (2005) Manufacturing of malt- milk based food products. Indian Dairyman, 57: 59-66.
5. Fast, R.B. and Caldwell, E.F. (1993) Breakfast Cereals and How They Are Made, American Association of Cereal Chemists, Inc., St. Paul, Minnesota, USA.
6. Hoseney, R.C., Wade, P. and Finely J.W. (1988) Soft Wheat Products, In: Wheat Chemistry and Technology, 3rd edn. (Y. Pomeranz, ed.) American Association of Cereal Chemists, St. Paul, MN.
7. Kulp, K. and Ponte, J.G. Jr. (2000) Handbook of Cereal Science and Technology, 2nd Edition, Marcel Dekker, Inc., New York, USA.
8. Lorenz, K.J. and Kulp, K. (1991) Handbook of Cereal Science and Technology, Marcel Dekker, Inc., New York, USA.
9. Matz, S. A. (1969) Cereal Science, Samuel A. Matz (Ed.) pp. 79-96. The AVI Publishing Company Inc., England.
10. NIN (2004) Nutritive Value of Indian Foods by: Gopalan, C., Rama Sastri, B. V. and Balasubramanian, Revised & Updated by: Narasinga Rao, B. S., Deosthale, Y. G. and Pant, K. C., National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.
11. Pomeranz, Y. and D. B. Bechtel (1978) Structure of cereal grains as related to end-use properties. Postharvest Biology and Biotechnology. H. O. Hultin and M. Milner, eds., Food and Nutrition Press, Inc., Westport, CN.

Sensory Evaluation of Dairy Products 2 (1+1)

Objective

To provide students with a comprehensive understanding of sensory evaluation techniques as applied to dairy products

Theory

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Terminology related to sensory evaluation; Design and requirements of a sensory evaluation laboratory; Basic principles: senses and sensory perception; Physiology of sensory organs; Classification of tastes and odours, threshold value; Factors affecting senses, visual, auditory, tactile and other responses.

Fundamental rules for scoring and grading of milk and milk products; Procedure and types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, hedonic scale and descriptive tests; Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements.

Milk: score card and its use; Judging and grading of milk, defects associated with milk; Cream: desirable attributes and defects in cream, Score card for cream, sensory evaluation of different types of cream; Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter; Ghee: grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee.

Fermented milks: desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks; Frozen dairy

products: desirable and undesirable characteristics of frozen dairy products; Sensory evaluation of ice cream, kulfi and milk sherbets; Cheese: sensory attributes of some common cheese varieties and their defects, score card for cheese; Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses; Dried dairy products: desirable and undesirable characteristic of dried milks; Sensory evaluation and grading of dry milk products; Concentrated milks: desirable attributes and defects; Sensory evaluation and grading of evaporated and condensed milk; Heat desiccated Indian milk products: desirable and undesirable characteristics.

Sensory evaluation of khoa and khoa based sweets; Acid coagulated Indian milk products: desirable arid undesirable characteristics; Sensory evaluation of paneer, chhana and chhana based sweets; Consumer acceptance studies: Objectives, methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and consumers studies, limitations; Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests.

Practical

Determination of threshold value for basic tastes; Determination of threshold value for various odours; Selection of sensory evaluation panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Sensory evaluation of milk and cream; Sensory evaluation of butter and ghee; Sensory evaluation of condensed and evaporated milk; Sensory evaluation of milk powders; Sensory evaluation of cheese and related products; Sensory evaluation of frozen products; Sensory evaluation of khoa and khoa-based sweets; Sensory evaluation of chhana and chhana based sweets; Sensory evaluation of dahi and fermented dairy products; Preparation of milk and milk products with defects, techniques for simulation; Novel techniques of sensory evaluation.

Suggested reading

1. Amerine, M.A., Pangborn, R.M. and Roessler, E.B. (1965). Principals of Sensory Evaluation of Food. Academic Press, New York.
2. Eggert, J. and Zook, K. (Eds). (1986). Physical Requirement Guidelines for Sensory Evaluation Laboratories. ASTM STP 913. American Society Testing and Materials, Philadelphia, PA.
3. Kemp, S.E., Hollowood, T. and Hort, J. (2009). Sensory Evaluation: A Practical Handbook. Wiley Blackwell, John Wiley and Sons Ltd. Publ., USA.
4. Meilgrard, M.J., Civille, C.V. and Carr, B.T. (2007). Sensory Evaluation Techniques. 4th ed. CRD, Boca Raton, F.L.
5. Russell, G. M. (1984). Some Basic Consideration in Computerizing the Sensory Laboratory. Food Tech, 38(9), 67-70.

Biochemistry and Human Nutrition 2 (1+1)

Objective

To develop understanding of fundamental principles of biochemistry and human nutrition including macro and micro nutrients requirements and the associated molecular and metabolic mechanism

Theory

Bio-Molecules: General structures, classification and functions of Biomolecules-Amino acids, Protein Structure, Carbohydrates, Fats, Lipids, DNA and RNA.

Enzymes: Activation energy /Transition state and Enzyme Classification, Coenzymes/Co-factors and Enzyme kinetics, Mechanism of enzyme action, Factors effecting enzyme activity, Enzyme inhibition, isozymes and Regulatory Enzymes, Immobilization of enzyme, Ribozymes and Zymogens.

Metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Glycogen synthesis and degradation, Pentose phosphate pathway, Fatty acid oxidation, Urea cycle and transaminase reactions, ATP and Electron transport chain.

Fundamentals of human nutrition, concept of balanced diet, nutrient requirements of different age groups; Methods of evaluation of nutritive value of food and nutritional value of cow, buffalo and human milk, biochemical composition and energy value of foods with special reference to milk and dairy products.

Nutrition, digestion and absorption, Vitamins (structure and function), Hormones (structure and function), Milk intolerance and hypersensitivity, Concept of functional foods and Nutraceutical, Milk based functional foods.

Practical

Estimation of alkaline phosphatase by conversion of a non-chromogenic substrate to a chromogenic substrate; Effect of temperature, pH and enzyme inhibitors on the activity of the enzyme; Estimation of catalase by spectrophotometric method; Determination of the Michaelis Menten constant of an enzyme; Estimation of RNA by colorimetric method; Estimation of DNA by colorimetric method; Estimation of Ascorbic acid in plasma; Estimation of serum Protein (Biuret method /Lowry method); Estimation of Blood Glucose (Folin Wu method); Estimation of Serum inorganic phosphorus (Fiske and Subba Row method);Estimation of blood creatinine, triglyceride and cholesterol levels; Estimation of calorific value of food items; Diet and nutrition surveys: (a) Identification of vulnerable and risk groups; (b) Diet survey for breast-feeding and weaning practices of specific groups; (c) Use of anthropometric measurement in children; Preparation of visual aids for nutritional disorders; Field visit to (a) Observe the working of nutrition and health oriented program (survey based result); (b) Hospitals to observe nutritional deficiencies; Identification of Mono, Di and Polysaccharides; Identification of Proteins (albumin, gelatin, peptone).

Suggested reading

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2002). Biochemistry. 5th edn. W. H. Freeman, New York.
2. Conn, E.E. and Stumpf, P.K. (2010). Outlines of Biochemistry. 5th edn. John Wiley and Sons, New York.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry. 4th edn. Garland Science, New York.
4. Nelson, D.L. and Cox, M.M. (2005). Lehninger's Principles of Biochemistry. 5th edn. W. H. Freeman, New York.

5. Staynarayana, U. and Chakrapani, U. (2006). Text Book of Biochemistry. 3rd edn. Oxford and IBH Publishers, New York.

6. Voet, D., Voet, J. G. and Pratt, C. W. (2006). Fundamentals of Biochemistry: Life at the Molecular Level, 3rd edn. John Wiley and Sons, USA.

ELECTIVE COURSES

(Total 8 credits of electives are to be taken out of the following indicative courses)

Course Title	Credit
Industrial Statistics	2 (1+1)
Fundamentals of Dairy Extension	2 (1+1)
Dairy Biotechnology	2 (1+1)
Instrumental Technique in Food Analysis	2 (1+1)
Food Additives and Preservatives	2 (1+1)
Design and Formulation of Foods	3 (2+1)

Industrial Statistics 2 (1+1)

Objective

To equip students with the knowledge and skills required to collect, analyze, and interpret data relevant to dairy and animal husbandry sector

Theory

Definition and scope; sources of animal husbandry and dairy statistics; Measures of central tendency, Measures of dispersion, Moments, skewness and kurtosis; Elementary notions of probability, Laws of addition and multiplication probability.

Theoretical frequency distributions: Binomial, Poisson and Normal distribution and their application; Concepts of sampling methods, Introduction to testing of hypotheses, Tests of Significance-Z, t, F tests, and their application in the field of dairying.

Analysis of variance- One-Way and two-way classification; Simple correlation coefficient and its test of significance, Linear regression, rank correlation.

Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

Practical

Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis Fitting of binomial and Poisson distribution; Application of 'Z' test for one and two sample problems; Application of 't' test for one and two sample problems; Application of Chi-square test and F-test; Correlation and regression; Rank correlation coefficient; Control chart for variables and attributes.

Suggested reading

1. Agarwal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd., New Delhi.

2. Amble, V. N. 1975. Statistical Methods in Animal Sciences. Indian Society of Agril. Statistics, New Delhi.
3. Goon, A. M., Gupta, M.K. and Gupta, B. D. 1979. Fundamental of Statistics. Vol. I and II. The World Press Pvt. Ltd., Kolkata.
4. Goulden, C.H. 1959. Methods of Statistical analysis. John Wiley and Sons, New York.
5. Gupta, S.C. 1987. Fundamental of Statistics. Himalaya Publishing House, New Delhi.
6. Gupta, S.C. and Kapoor, V.K. 1990. Fundamentals of Applied Statistics. Sultan Chand & Sons, New Delhi.
7. Gupta, S.P. 2010. Statistical Methods. Sultan Chand and Sons, New Delhi.
8. Handbook on Statistical Quality Control. 1986 . Indian Standards Institute, New Delhi.
9. Moroney, M.J. 1975. Facts from Figures. Penguin Books, England.
10. Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH Publishing Co., New Delhi.

Fundamentals of Dairy Extension 2 (1+1)

Objective

To provide students with a basic understanding of extension education principles and practices within the context of dairy and animal husbandry

Theory

History, need, definition, philosophy, principles, approaches and objectives of extension education; Present status of dairy and animal husbandry development programme launched in pre and post-independence era; Teaching and learning process, Extension Teaching Methods, classification and selection of teaching methods; Importance of Audio-Visual-Aids; Identification of rural leaders, their characteristics, role and function in rural development, training of rural leaders; Principle of working with group and their mobilisation; Need, principle and step of programme planning; Evaluation of extension program; Diffusion of innovations and categories of farmers; Problems of different stake holders, Conceptual orientation about different terms, like- RRA, PRA, IVLP/TAR, ATMA, ATIC, PTD, etc.

Practical

Acquiring skill in use of audio-visual and other aids: Hands-on training on use of LCD projector, PA system, camera; Skills in preparation of documents including script writing; Preparation and use of audio-visual aids including animation for dairy stakeholders Group discussion technique, Hands on learning of field problems in dairy and animal husbandry.

Suggested reading

1. Adams, M.E. (1982). Agricultural Extension in Developing Countries. Longman, Singapore Publ.
2. Blackburn, D.J. and Vist, D.L. (1984). Historical Roots and Philosophy of Extension. In D. J. Blackburn (Ed.), Extension handbook, University of Guelph, Guelph, Ont., Canada.
3. Burton, E.S., Robert, P.B. and Andrew, J.S. (1997). Improving Agricultural Extension – A Reference Manual. FAO, Rome.

4. Chouhan, J. (2006). Communication and Extension Management. Anjali Prakashan, Kanpur.
5. Dahama, O.P. and Bhatnagar, O.P. (1987). Education and Communication for Development. Oxford & IBH.
6. Farrington, J., Pal, S., Sulaiman, R. V. (1998). Improving the Effectiveness of Agricultural Research and Extension in India, Policy Paper 8, NCAP, New Delhi.
7. Hayward, J. 1990. Agricultural Extension: The World Bank's Experience and Approaches. In FAO Report of the Global Consultation on Agricultural Extension (p. 115-134). Rome: FAO.
8. Jha, D. and Kandaswamy, A. (Eds). (1994). Decentralising Agricultural Research and Technology Transfer in India. ICAR, New Delhi.
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12. Moris, J. (1991). Extension Alternatives in Tropical Africa. Overseas Development Institute, London.
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15. Reddy, A.A. (1993). Extension Education. Shree Laxmi Press, Bapatla, Andhra Pradesh.
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17. Samanta, R.K. (1993). Extension Strategy for Agricultural Development in 21st Century. Mittal Publications, New Delhi.
18. Swanson, B.E. (Ed). (1984). Agricultural Extension: A Reference Manual. 2nd edn. FAO, Rome.
19. Van den Ban, A.W. and Hawkins, H.S. (1998). Agricultural Extension. Longman Scientific Tech., UK.

Dairy Biotechnology 2 (1+1)

Objective

To provide students with understanding of biotechnological applications in dairy industry.

Theory

Definition, scope and historical development of biotechnology, achievement and future application. Structure of DNA and RNA; DNA replication, protein synthesis, genetic code, mutations. Vectors, cloning strategies in bacteria and animals, rDNA technology and Protoplast fusion; Application of biotechnology in food and dairy industry, dairy effluents; Genetic manipulation of dairy starters for improved attributes of commercial value; Dairy enzymes and whole cell immobilization; Ethical issues related to use of genetically modified foods; Ethical issues related to use of genetically modified foods.

Practical

Isolation of plasmid and genomic DNA from bacteria (E; coli, lactic acid bacteria); Agarose gel electrophoresis of DNA fragments); Restriction analysis of DNA; Curing of plasmids; Preparation of competent cell; Transformation of *E; coli* by calcium chloride treatment/ electro oration; Conjugal transfer in *E; coli* cells; Preparation of protoplasts and protoplast fusion; PCR technique demonstration; Visit to a biotechnology lab.

Suggested reading

1. Belitz, H.D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
2. Deshpande, S.S. (2002). Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Mahindru, S.N. (2008). Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

Instrumental Techniques in Food Analysis 2 (1+1)

Objective

To expose students to principles and theory of selected instrumental methods used in food analysis

Theory

Concepts of food analysis; Rules and regulations of food analysis.

Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods. Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry. Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Quality evaluation of raw materials: Fruits products; Quality evaluation of raw materials: vegetables products; Quality evaluation of raw materials: cereals products; Quality evaluation of raw materials: dairy products; Quality evaluation of food products for color and taste of marketed products (sweet); Quality evaluation of food products for color and taste of marketed products (carbonated drinks; Quality evaluation of food products for color and taste of marketed products (Processed food); Quality evaluation of food products for color and taste of marketed products (Chili powder); Estimation

of phytic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Analysis of heavy metals using atomic absorption spectrophotometer (mercury/ lead/arsenic/tin); Identification of organic acids by paper electrophoresis; Estimation of vitamins (A) using HPLC; Estimation of vitamins (thiamine) using HPLC; Estimation of vitamins (riboflavin) using HPLC; Estimation of vitamins (nicotinamide) using HPLC; Estimation of lycopene using HPLC; Estimation of betacarotein using HPLC; Estimation of vitamins A using HPLC; Analysis of foods for drug residues in milk/milk products; Analysis of foods for pesticide residues in fruit; Analysis of foods for pesticide residues in vegetable; Analysis of foods for pesticide residues in spices; Spectrophotometric method of total chlorophyll (A and B); Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE; Fatty acid profiling using gas chromatograph.

Suggested reading

1. Nielsen, S. Suzanne. (2003). Food Analysis. 3rd edn. Kluwer Academic, New York, USA.
2. Nielsen, S. Suzanne. (2010). Food Analysis Laboratory Manual. 2nd edn. Springer, NY, USA.
3. Semih Ötles. (2009). Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
4. Sun, Da-Wen. (2008). Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

Food Additives and Preservatives 2 (1+1)

Objectives

1. To introduce the different additives and preservatives used in food industry.
2. To understand the mode of action of additives and preservatives used in food products. Students will also be familiarized with regulatory requirements of food additives.

Theory

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action; Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic);Identification of food colour by TLC (organic and inorganic);Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in foods; Role of leavening agent in baked food product; Preservation of food samples using humectants.

Suggested reading

1. Belitz, H. D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
2. Deshpande, S.S. (2002). Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Mahindru, S. N. (2008). Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

Design and Formulation of Foods 3 (2+1)

Objectives

1. Understand about RDA for Indians
2. Design and formulation of new and innovative target foods
3. Gain knowledge about various functional foods

Theory

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people; Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition; Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation; Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods; Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Suggested Reading

1. Antia, F.P. 1974. Clinical Dietetics and Nutrition, Oxford Medicine Publications.
2. Davidson, S., Passmore, R. and Eastwood, M.A. 1986. Davidson and Passmore Human Nutrition and Dietetics. Churchill Livingstone.

3. Gopalan, C., Ramshastri, B.V., Balasubramaniam, S.C. 1989. Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad.
4. Pokorny, J., Yanishlieva, N. and Gordon, M. 2001. Antioxidants in Food, Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science, 5th edn. Chapman & Hall, NY, USA.
6. Mazza, G.1998. Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson, C. 1975. Basic Nutrition and Diet Therapy, Macmillan.
8. Swaminathan, M.1974. Essentials of Nutrition, Ganesh Co.
9. Steinkrauss, K.H. 1995. Handbook of Indigenous Fermented Foods, Marcel Dekker.

SEMESTER-VIII

S; No;	Course Title	Credit Hours
1	In-plant Training	One Semester (0+20)
	Total	20 (0+20)
For B. Tech; program: Course at 1 to be offered (20 credits) In-plant training for one semester to be carried out at a Dairy processing plant		

- In eighth semester of the degree program students will be offered Internship (In-plant training) of 20 credits.
- The Training will be carried out at a commercial dairy plant.
- The students will be exposed to processing, production, testing and quality assurance and marketing of dairy products at commercial scale.
- The students would be required to submit a certificate of completion of the training from the concerned authorities of the company.

ONLINE COURSES

The students will have to take a minimum of 08 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Dairy Technology). The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by the Institute/ University offering the courses. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student. The courses can be taken during whole span of degree parogramme as per choice of students. The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course). The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

List of Suggestive Online Course

Course Title	Duration	Credit
Digital Media	16 weeks	1
Basics of Photography	12 weeks	1
Design, Technology and Innovation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Communication and Extension for Sustainable Development	15 weeks	1
Intellectual Property	12 weeks	1
Biopsychology	15 weeks	1
NGO'S and Sustainable Development	15 weeks	1
Counselling Psychology	12 weeks	1
Gender Sensitization: Society Culture and Change	16 weeks	1
Basics of Health Promotion and Education Intervention	8 weeks	1
Psychology of Stress, Health and Well-being	12 weeks	1
Diet Management in Health & Disease	12 weeks	1
Dairy and Food Process and Products Technology	12 weeks	1
Thermal Processing of Foods	12 weeks	1
Nano-technology, Science and Applications	8 weeks	1
Food Science & Processing	12 weeks	1
Diet Management in Health & Disease	8 weeks	1
Human Nutrition and Biochemistry	12 weeks	1
Personality Development and Communication Skills	8 weeks	1
Public Speaking	8 weeks	1
Personality Development	8 weeks	1
Personality Development	8 weeks	1
Yoga Practices 1	12 weeks	1
Yoga Practices 2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1
Information Sources and Library Services	6 weeks	1
Qualitative Research Methods and Research Writing	12 weeks	1
Food Science & Processing	12 weeks	1
Food Safety & Quality Control	8 weeks	1
Communication Skills and Computer Operations	24 weeks	1
Human Resource Management	24 weeks	1
Business Plan and Finance Management	24 weeks	1

SAUs will be free to include more Elective courses with approval from their competent bodies.

* The list of online courses will be uploaded on College/University website. The student will have choice to select courses of his/her choice up to 08 credits.

FISHERIES SCIENCE

Course Curricula for Undergraduate Program in Fisheries Science
UG- Certificate (Fisheries Science) UG- Diploma (Fisheries Science)
B. F. Sc. (Hons.)

INTRODUCTION

The fisheries sector is a critical and fastest-growing allied agricultural sector in India, contributing to the national income, exports, food and nutritional security, and employment generation. In FY 2022-23, the total fish production in India was estimated at **17.54 million metric tons**, with **13.11 million metric tons** from the inland sector and **4.43 million metric tons** from the marine sector. The annual average growth rate in the fisheries sector has been **7%** over the last five years. The fisheries sector is an important source of food, nutrition, income, and livelihood for millions of people. It has shown an impressive growth rate of **9.03%** (Constant Price: 2011-12) during the years 2015-16 to 2020-21. The fisheries sector's share in the total Gross Value Added (GVA), at Constant prices, in 2022-2023 is estimated at **₹137,716 crore** that constitutes about **1.09%** of the total national GVA and **6.72%** of agricultural GVA. India is the third-largest fish-producing country and the fourth-largest exporter of fish and fisheries products in the world, contributing **7.96%** of the global production and taking Brand India from Local to Global. The fisheries sector is also a principal source of livelihood for a large section of the economically underprivileged population of the country, with about **28 million people** (16 million male and 12 million female) directly and indirectly involved in the fisheries sector for their livelihood.

The development of the sector depends on strong, skilled, and educated human resources. The education on the subject again depends on the modern, more competitive, marketability, and employability course curricula, which is the backbone of the sector. Fisheries colleges are rapidly coming up all over the country, almost in all the states. Hence, a common academic course curriculum and regulations are paramount to achieving necessary quality and need-based agricultural education. In this background, a restructured undergraduate course curriculum has been developed in the light of the National Education Policy (NEP-2020).

The restructured course curriculum in India aims to strengthen critical thinking, creativity, communication, and collaboration among students. The course begins with a three-week immersion-cum-foundation program that instils life and social skills, social awareness, ethics and values, team work, leadership, creativity, and more. The restructured course curriculum in India emphasizes skill enhancement courses, rural fisheries work experience, research works, in-plant training, industry attachments, flexibility in the choice of courses via electives, and online courses of MOOCs/ SWAYAM, etc. The curriculum also provides for advanced skill enhancement through project work or experiential learning/incubation. Through such activities, the curriculum emphasizes conceptual learning over rote learning and inculcates integrity and critical thinking. As per NEP, the curriculum also includes multiple exit and entry options.

The semester-wise course structure for undergraduate courses in Fisheries viz. UG-Certificate, UG-Diploma and B. F. Sc. (Hons.) have been prepared after multi-stage in-depth deliberations and discussions through virtual meetings and personal communications with committee members, Deans' and faculty members of the Fisheries Colleges of different SAUs and CAUs, stakeholders from related industries, Govt. Institutions, and alumni. The curriculum is expected to strengthen the knowledge and skill base of students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The undergraduate program of B. F. Sc. (Hons.) is of **182 credit hours** comprising**172 credit hours** of coursework and **10 credit hours** of online courses (MOOCs/SWAYAM etc.). The minimum eligibility requirement for admission in the undergraduate program on Fisheries will be the same as the existing system followed by SAUs (State Agricultural University)/ CAUs (Central Agricultural University).
- After the admission of students in the university, the students will register for the *Deeksharambh* of two weeks' duration in the 1st semester. The course will include, but not restricted to, discussions on the operational framework of the academic process in the university, interactions with alumni, business leaders, scientists and perspective employers, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated to knowledge and skill enhancement, including applied aspects of Fisheries. After satisfactory completion of two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of internship/ industry/ institute/ farm attachment, the student will become eligible for the award of UG-Certificate in Fisheries on exit. Students continuing their studies further would not have to attend the internship after the 1st year.
- The second year has been designed with practical exposure on Fisheries as well as skill enhancement courses and some part of fundamental courses related to fisheries with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of fisheries. After satisfactory completion of four semesters and subsequent satisfactory completion of 10 credits (10 weeks) of internship/ industry/ institute/ farm attachment, the student will become eligible for the award of UG-Diploma in Fisheries on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- The undergraduate program in India offers a Skill Enhancement program during the first and second years. Students have the flexibility to choose skill enhancement areas from a bouquet of Skill Enhancement Courses offered by the parent institute. After a one-week common orientation on different skill enhancement courses, students can take up one or more courses (maximum 4 credits in each semester) as per local needs and gain complete hands-on experience on these subjects. In addition to the proposed courses in this report, the SAUs/CAUs can formulate other courses relevant to their respective regions or modify the proposed courses as applicable. An institution is at liberty to work in partnership with capable organizations/ companies/ NGOs/progressive entrepreneurs for running various skill enhancement programs. In such cases, the parent institution will control the admission process, develop the content and delivery of the program, and monitor the learning and skill enhancement by students. The evaluation can be done jointly by the collaborating partners.
- The third and fourth years of the course are designed to impart in-depth details, including specialized knowledge to students in the major disciplines. During the 5th semester, the students will have a study tour of 10-14 days' duration, which will be counted as 2 credits (non-gradial).

- In the final year (7th Semester), students will have adequate choice of electives/specialized courses (20 credits). The SAUs/CAUs will have the flexibility to include more courses as electives depending on specific needs. The objective is to enable the student to acquire a deeper understanding of any field. The SAUs/CAUs may modify the contents of individual courses to the extent of 30 percent whenever necessary as per the regional demands and needs.
- In the 8th Semester, students opting for the 4-year B. F. Sc. (Hons.) degree will undergo 20 credits of Student READY (Rural Entrepreneurship Awareness Development Yojana) program. This program includes the Rural Fisheries Work Experience (RFWE), Experiential Learning (EL), In Plant Training/Industrial Attachment, and Student Project to provide practical experience in real-life situations, create awareness about practical agriculture and allied sciences, and develop entrepreneurial skills among the graduates. The program also helps in building confidence, skills, and acquiring Indigenous Technical Knowledge (ITK) of the locality, thereby preparing the pass-out for self-employment.
- In addition to the prescribed courses, students will have the freedom to opt for 10 credits of non-credit courses from MOOCs/SWAYAM or any other online portal to groom their passion and add to their knowledge components based on their choice. These non-credit courses can be from any field such as Agriculture, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including Foreign Languages, Communication Skills/Music, etc. The objective is to allow students to groom their passion or strengthen their knowledge and competency in any field beyond the prescribed courses. Students will have the flexibility to complete these courses of 10 credits throughout the span of the degree program. These online courses will be non-gradial, and separate certificates will be issued by institutes offering the courses. However, the SAUs/CAUs will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in the final transcript issued to the student.

Entry and Exit Options

The entry and exit options for the UG program in Fisheries science are shown in Figure 1.

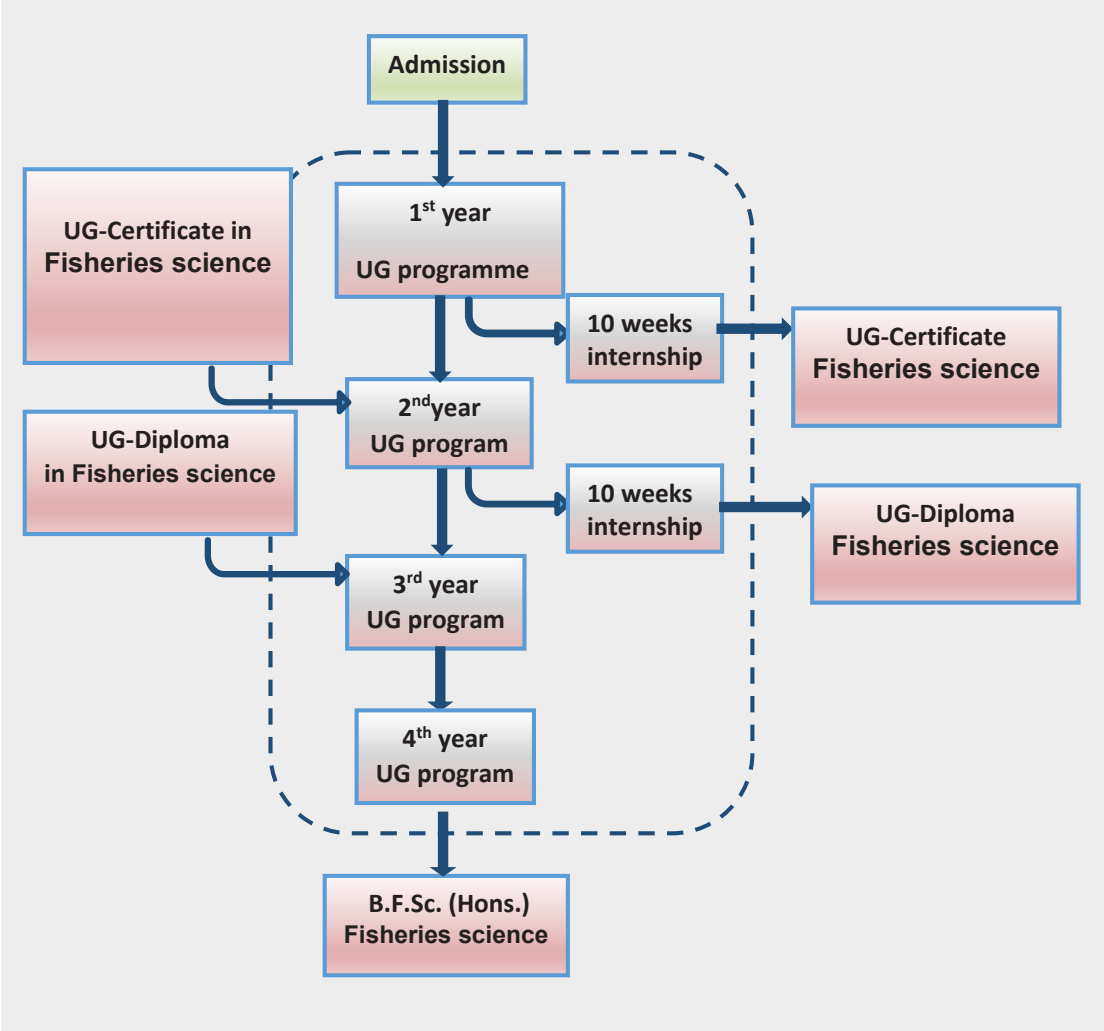

Figure 1: Entry and Exit options for the UG program in Fisheries Science

Exit options

1. **UG-Certificate in Fisheries science** (Exit after the first year and completion of 10 weeks' Internship)
2. **UG-Diploma in Fisheries science** (Exit after second year and completion of 10 weeks' Internship)
3. **B. F. Sc. (Hons.)** (On successful completion of four-year degree requirements)

Eligibility Criteria: 10+2 or intermediate with Physics, Chemistry, Mathematics, Biology from a recognized Board/University or as per the criteria decided by the ICAR/ SAU.

ACADEMIC PROGRAM

Semester-wise course distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
First Year			
I semester			
1.	Deeksharambh (Induction-cum-Foundation course of 2 weeks)	2 (0+2) Non-gradial	**23 (10+13)**
2.	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)	
3.	Soil and Water Chemistry	3 (2+1)	
4.	Freshwater Aquaculture	3 (2+1)	
5.	Fundamental Microbiology	2 (1+1)	
6.	Meteorology and Geography	2 (1+1)	
7.	Farming Based Livelihood Systems	3 (2+1)	
8.	Communication Skills	2 (1+1)	
9.	NCC-I/NSS-I	1 (0+1)	
10.	Skill Enhancement Courses* (SEC-I)	2 (0+2)	
11.	Skill Enhancement Courses* (SEC-II)	2 (0+2)	
II semester			
1.	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)	**24 (12+12)**
2.	Anatomy and Biology of Finfish and Shellfish	3 (2+1)	
3.	Physiology of Finfish and Shellfish	3 (2+1)	
4.	Limnology	2 (1+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Personality Development	2 (1+1)	
8.	NCC-II/NSS-II	1 (0+1)	
9.	Skill Enhancement Courses* (SEC-III)	2 (0+2)	
10.	Skill Enhancement Courses* (SEC-IV)	2 (0+2)	
Post Semester-II (only for exit option for award of UG- Certificate)			
1.	Internship (for 10 weeks)	10** (0+10)	**10** (0+10)**
III Semester			
1.	Coastal Aquaculture and Mariculture	3 (2+1)	**21 (10+11)**
2.	Fish Nutrition and Feed Technology	3 (2+1)	
3.	Inland Fisheries	2 (1+1)	
4.	Fishing Craft Technology	2 (1+1)	
5.	Fundamentals of Biochemistry and Food Chemistry	2 (1+1)	
6.	Post-Harvest Handling and Preservation	3 (2+1)	
7.	Fisheries Extension	2 (1+1)	
8.	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)	
9.	Skill Enhancement Courses* (SEC-V)	2 (0+2)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
	IV Semester		
1.	Breeding and Culture of Ornamental Fish	2 (1+1)	**23 (13+10)**
2.	Live Food Organisms for Fish and Shellfish	2 (1+1)	
3.	Fish and Shellfish Diseases and Treatment	3 (2+1)	
4.	Marine Fisheries	2 (1+1)	
5.	Fishing and Gear Technology	3 (2+1)	
6.	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)	
7.	Agriculture Marketing and Trade	3 (2+1)	
8.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9.	Skill Enhancement Courses* (SEC-VI)	2 (0+2)	
	Post Semester IV (Only for exit option for award of UG -Diploma)		
1.	Internship (for 10 weeks)	10*** (0+10)	**10*** (0+10)**
	V Semester		
1.	Fish Genetics and Breeding-	2 (1+1)	**21 (12+9)**
2.	Marine Biology	2 (1+1)	
3.	Fish Population Dynamics and Stock Assessment	2 (1+1)	
4.	Aquatic Ecology and Biodiversity	2 (1+1)	
5.	Pharmacology and Toxicology	3 (2+1)	
6.	Fish Freezing Technology	2 (1+1)	
7.	Fish Canning Technology and Packaging	2 (1+1)	
8.	Aquaculture Engineering	3 (2+1)	
9.	Fisheries Economics	3 (2+1)	
10.	Education Tour (2 Weeks)	NG	
	VI Semester		
1.	Fish Biotechnology and Bioinformatics	2 (1+1)	**20 (11+9)**
2.	Fish Immunology	2 (1+1)	
3.	Therapeutics in Aquaculture	2 (1+1)	
4.	Coastal Zone Management	2 (1+1)	
5.	Microbiology of Fish and Fisheries Products	2 (1+1)	
6.	Refrigeration and Equipment Engineering	2 (1+1)	
7.	Navigation and Seamanship	2 (1+1)	
8.	Statistical Methods	3 (2+1)	
9.	Fisheries Policy and Laws	1 (1+0)	
10.	Fisheries Co-operative and Marketing	2 (1+1)	
	VII Semester		
1.	Elective Courses (Major)#	12	**20**
2.	Elective Courses (Minor)##	8	

Sl. No.	Course Title	Credit Hours	Total Credit hours
	VIII Semester		
Student opting for 4-year B. F. Sc. (Hons.) a Student READY (Students Entrepreneurship Awareness Development Yojana) Program on In-plant/Industry Attachment / Rural Fisheries Work Experience (RFWE) Program/ Experiential Learning Program (ELP) / Project Work) / Seminar will be undertaken as follows.			
1.	In-plant/ Industry Attachment (for 8 weeks)	5 (0+5)	**20 (0+20)**
2.	Rural Fisheries Work Experience (RFWE) Program (for 8 weeks)	6 (0+6)	
3.	Experiential Learning Program (ELP)	6 (0+6)	
4.	Project Work	2 (0+2)	
5.	Seminar	1 (0+1)	

* From the basket of courses of Skill Enhancement Courses
** Mandatory requirement for UG-Certificate.
*** Mandatory requirement for UG-Diploma.
#Students have option to choose any Four Major Courses (12 credits) from the list of courses
Students have option to choose any Four Minor Courses (08 credits) from the list of courses

Department/ section wise course breakup

Sl. No.	Course Title	Credit Hours
1.	Freshwater Aquaculture	3 (2+1)
2.	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)
3.	Coastal Aquaculture and Mariculture	2 (1+1)
4.	Breeding and Culture of Ornamental Fish	2 (1+1)
5.	Fish Nutrition and Feed Technology	3 (2+1)
6.	Fish Genetics and Breeding	2 (1+1)
7.	Biotechnology and Bioinformatics	2 (1+1)
8.	Live Food Organisms for Fish and Shellfish	2 (1+1)
9.	Open-water Aquaculture	3 (2+1)
10.	Smart Aquaculture Production Systems	3 (2+1)
11.	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)

Sl. No.	Course Title	Credit Hours
1.	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)
2.	Anatomy and Biology of Fish and Shellfish	3 (2+1)
3.	Physiology of Fish and Shellfish	3 (2+1)
4.	Inland Fisheries	2 (1+1)
5.	Marine Fisheries	2 (1+1)
6.	Fish Population Dynamics and Stock Assessment	2 (1+1)
7.	Sustainable Fisheries Management and Conservation	3 (2+1)

Sl. No.	Course Title	Credit Hours
1.	Soil and Water Chemistry	3 (2+1)
2.	Meteorology and Geography	2 (1+1)
3.	Limnology	2 (1+1)
4.	Aquatic Ecology and Biodiversity	2 (1+1)
5.	Coastal Zone Management	2 (1+1)
6.	Marine Biology	2 (1+1)
7.	Aquatic Pollution	3 (2+1)
8.	Fishery Oceanography	3 (2+1)
9.	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)
10.	Climate Change and its Impact on Fisheries	2 (0+2)
11.	Aquatic Microbiology	2 (1+1)

Sl. No.	Course Title	Credit Hours
1.	Fundamental Microbiology	2 (1+1)
2.	Fish and Shellfish Diseases and Treatment	3 (2+1)
3.	Pharmacology and Toxicology	3 (2+1)
4.	Fish Immunology	2 (1+1)
5.	Therapeutics in Aquaculture	2 (1+1)
6.	Fish and Shellfish Pathology	3 (2+1)
7.	Disease Diagnostics Techniques	3 (2+1)

Sl. No.	Course Title	Credit Hours
1.	Fundamentals of Biochemistry and Food Chemistry	3 (2+1)
2.	Post-Harvest Handling and Preservation	2 (1+1)
3.	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)
4.	Fish Freezing Technology	2 (1+1)
5.	Microbiology of Fish and Fisheries Products	2 (1+1)
6.	Fish Canning Technology and Packaging	2 (1+1)
7.	Quality Assurance of Fish and Fishery Products	3 (2+1)
8.	Principles and Techniques of Seafood Analysis	2 (1+1)
9.	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)

Sl. No.	Course Title	Credit Hours
1.	Fishing Craft Technology	2 (1+1)
2.	Fishing and Gear Technology	3 (2+1)
3.	Aquaculture Engineering	3 (2+1)
4.	Refrigeration and Equipment Engineering	2 (1+1)
5.	Navigation and Seamanship	2 (1+1)
6.	GIS and Remote Sensing in Fisheries	2 (1+1)
7.	Responsible and Sustainable Fishing Methods	2 (1+1)

Sl. No.	Course Title	Credit Hours
1.	Fisheries Extension	2 (1+1)
2.	Fisheries Economics	3 (2+1)
3.	Statistical Methods	3 (2+1)
4.	Fisheries Policy and Laws	1 (1+0)
5.	Fisheries Co-operative and Marketing	2 (1+1)
6.	Marketing Intelligence and Business Analysis	2 (1+1)
7.	ICT in Fisheries	2 (1+1)
8.	Gender in Fisheries	2 (1+1)

Basic Supporting Courses

Sl. No.	Course Category	Course Title	Credit Hours
1.	FC	*Deeksharambha* Induction-cum-Foundation course) 2 weeks duration	2 (0+2) Non-Gradial
2.	MDC	Farming-Based Livelihood Systems	3 (2+1)
3.	MDC	Entrepreneurship Development and Business Management	3 (2+1)
4.	MDC	Agriculture Marketing and Trade	3 (2+1)
5.	VAC	Environmental Studies and Disaster Management	3 (2+1)
6.	VAC	Agricultural Informatics and Artificail Intellegnece	3 (2+1)
7.	AEC	Communication Skills	2 (1+1)
8.	AEC	Personality Development	2 (1+1)
9.	AEC	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)
10.	AEC	NSS/ NCC	2 (0+2)
11.		Educational Tour (2 Weeks Duration)	Non-Gradial

Summary of Credit Distributions

Type of courses		Credits
Core courses (Major and Minor/s)	:	117
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	**172+10****

Table 1: Credits Allocation Scheme of UG Fisheries Science Programs (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	13	$3^{(2)}$	-	$1^{(3)} + 2^{(4)}$	4	-	23	$2^{(1)}$		
II	11	$3^{(5)}$	$3^{(6)}$	$1^{(3)} + 2^{(7)}$	4	-	24	-	$10^{(12)}$	

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
III	17	-	-	2[8]	2	-	21	-		
IV	15	3[9]	3[10]	-	2	-	23	-	10[13]	**10**
V	21	-	-	-	-	-	21	2[11]		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	1. -	-	20	20	-		
Total	**117**	9	**6**	**8**	**12**	**20**	**172**	**4**		**10**

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems
(3) NCC/NSS/NSO
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices, and Meditation
(9) Agriculture Marketing and Trade
(10) Agricultural Informatics and Artificial Intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

DETAILED SYLLABI

SEMESTER-I

Deeksharambh (Induction-cum-Foundation Program) 2 (NG)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of the academic process in the university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenarios.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on the operational framework of the academic process in the university, as well as interactions with academic and research managers of the University
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

- Activities to enhance cultural Integration of students from different backgrounds
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Taxonomy of commercially important fish and shellfish **3 (1+2)**

Objectives

1. To identify the commercially-important fish and shell-fish species inhabited in the aquatic environment
2. To acquire knowledge on the fish and shell-fish species in the aquatic environment

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyo-taxonomy, DNA barcoding, protein analysis and DNA polymorphism.

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

Practical

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition.

Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, and cephalopods from natural habitats. Field visits for collection and study of commercially important shellfish.

Suggested readings

1. Bal DV and Rao KV. 1990. Marine Fishes of India. 1st Revised edn. Tata McGraw Hill.
2. Day F. 1878. The Fishes of India. William Dawson and sons Ltd.
3. FAO. 2000. DNA-based molecular diagnostic techniques.
4. Fischer W and Biachi G. 1984. FAO-identification sheets for fishery purposes. Vol I-VI pages' variable
5. Hamilton F. 1822. Fishes of the River Ganges and its branches. Publ. Edinberg.
6. Jayaram KC. 2010. The freshwater fishes of the Indian Region II edition. Narendra Publishing house New Delhi

7. Kurian CV and Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
8. Jayaraman KC. 2002. Fundamentals of Fish Taxonomy. Publ.
9. Mayr E. 1977. Principles of Systematic Zoology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi, p. 428.
10. Nelson JS. 2006. Fishes of the World, 4th edn, John Wiley and Sons.
11. Ponniah AG and George John. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow publication.
12. Talwar PK and Jhingran AG. 1991. Inland fishes of India and adjacent countries, Delhi Oxford and IBH Publishing Co. Pvt. Ltd. 1158 p. Vol. I and II.
13. Talwar PK and Kacker RK. 1984. Commercial Sea Fishes of India. ZSI, Kolkata. 997 p.
14. Thomas D, Kocher and Carol A Stepien (Ed.). 1997. Molecular Systematics of Fishes. Academic Press. New York. 314p.

Soil and Water Chemistry 3 (2+1)

Objectives

1. To analyse the water and soil quality parameters in relation to aquaculture for assessing the health of the water bodies
2. To study the impact of water and soil quality parameters on fish and shellfish production

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve, nomograph. Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Dissolved gasses: Factors affecting natural waters. Acid, base, salts, Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Soil Chemistry: Origin and nature of soils. Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation.

Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

Practical

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis. Water analysis: measurement of temperature, turbidity, determination of pH and EC. Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO_2. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus.

Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

Suggested readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd Edition. American Public Health Association, Washington, D.C
2. Boyd, C.E., Wood, C.W. and Thunjai, T. 2002. Aquaculture pond bottom soil quality management. Oregon State University, Corvallis, Oregon.
3. Bryan M Ham and Aihui MaHam. 2016. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, Wiley.
4. Cheremisinoff NP. 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann, Woburn.
5. Jeffery GH, Basset J, Mendham J and Denney RC. (Eds). 1989. Vogel's Textbook of Quantitative Chemical Analysis. Longman Publishers, Singapore.
6. Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA, Johnston CT and Sumner ME. (Eds). 1996. Methods of Soil Analysis: Part 3 - Chemical Methods. SSSA-ASA, Madison.

Freshwater Aquaculture 3 (2+1)

Objectives

1. To gain knowledge and understand the recent advances in freshwater aquaculture under different culture systems
2. To impart the knowledge of the different types of aquaculture methods and commercially importable freshwater fish and shell-fish species

Theory

Major species cultured, production trends and prospects in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs, etc. Nursery, rearing and grow out ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods - Indian major carps, exotic carps, air-breathing fishes, cold water fishes, freshwater prawns, freshwater mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian

and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfishes and murrels. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/ horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

Practical

Preparation and management of nursery, rearing and grow-out ponds. Study on the effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of the economics of different culture practices. Estimation of livestock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

Suggested readings

1. Agarwal SC. 2008. A Handbook of Fish Farming. 2nd edn. Narendra Publ. House.
2. De Silva SS. (Ed.). 2001. Reservoir and Culture Based Fisheries: Biology and Management. ACAIR Proceedings.
3. FAO. 2007. Manual on Freshwater Prawn Farming.
4. Midlen and Redding TA. 1998. Environmental Management for Aquaculture. Kluwer.
5. New MB. 2000. Freshwater Prawn Farming. CRC Publ.
6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
7. Pillay TVR. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambridge University Press, Cambridge.
8. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
9. Venugopal S. 2005. Aquaculture. Pointer Publ.
10. Welcomme RL. 2001. Inland Fisheries: Ecology and Management. Fishing News Book
11. ICAR. 2006. Handbook of Fisheries and Aquaculture.
12. Jhingran V.G. 1991. Fish and Fisheries of India, 3rd edn, Hindustan Publ.

Fundamental Microbiology 2 (1+1)

Objectives

1. To create a basic understanding on microbiology and its importance in the aquatic environment
2. To develop skills in the identification of microbes, culture of microbes, and diagnosis of microbial pathogens in aquatic organisms

Theory

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM. Microbial taxonomy–Bergy's and

molecular taxonomy. Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods. Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation –types and significance. Microbial ecology: Introduction and types of interaction, extremophiles and their significance.

Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses. Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self-purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

Practical

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry. Determination of size of microorganisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, dry heat, moist heat, chemical agents. Cultivation technique: Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems. Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.

Suggested readings

1. Chakraborthy P. 1995. A Text Book of Microbiology. New Central Book Agency.
2. Criusted J. 1986. Methods in Microbiology. Academic Press.
3. Harry WSJR, Paul JV and John JL. 2000. Microbes in Action. Freeman andCo.
4. James M. 1978. Modern Food Microbiology. 2nd edn. D. Van Nostrand Co.
5. Michael J, Pelizar JR and Chan ECS. 1998. Microbiology. Tata McGraw Hill.
6. Paul JH. 2001. Marine Microbiology - Methods in Microbiology. Vol. XXX. Academic Press.
7. Samuel CP and Dunn CG. 1959. Industrial Microbiology. McGraw Hill.

8. Silliker JH, Elliof RP, Baired AC and Boyan FL. 1980. Microbial Ecology of Foods. Vol. II (ICMSF). Academic Press.
9. William CF and Westhoff DC. 2000. Food Microbiology. Tata Mc Graw Hill.
10. Khuntia B. K. 2021. Basic Microbiology- A Illustrated Laboratory Manual. Daya Publ.

Meteorology and Geography 2 (1+1)

Objective

- To teach the meteorological phenomena and geographical distribution

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: the relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements.

Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms.

Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.

Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion.

Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.

Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector.

Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Practical

Graphic representation of the structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Isotherms: world mean Temperatures-January to July. India means temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December;

isohyets. Atmospheric pressure measurement: Fortin's mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

Suggested Readings

1. Ahrens, C. Donald. 2011. Essentials of Meteorology: An Invitation to the Atmosphere, International Edition, Brooks/Cole Publ.
2. Barry Roger G. 2009. Atmosphere, Weather and Climate, Taylor and Francis Ltd.
3. Maury, Matthew_Fontaine._ 2018. The Physical Geography of the Sea, and Its Meteorology, Palala Publ.
4. Naik M. Ganapathi . 2013. Meteorology and Geography, Narendra Publishing House.
5. Spiridonov V. 2021. Fundamentals of Meteorology, Springer.
6. The Indian Meteorological Department (IMD), Weather Instruments, Maps and Charts, In Practical Geography. 2022-23.

Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill, and how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting the integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculturally based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop-based, livestock-based, processing-based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about the concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India
2. Ashley, C. and Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK. Volume 7. [Google Scholar]
3. Carloni, A. (2001) Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and Gulliver A. with Gibbon, D. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & and World Bank, Rome, Italy & and Washington, DC, USA
5. Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objectives

- To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication- A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

National Cadet Corps (NCC-I) 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defence organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, the contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) 1 (0+1)

Objective

Evoking social consciousness among students through various activities, viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.

- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

SEMESTER-II

Fish and Shellfish Breeding and Hatchery Management 3 (2+1)

Objectives

1. To acquire knowledge and hands-on-training on the processes and practices of fish and shellfish breeding, hatchery management and quality seed production of different cultivable fish and shellfish species
2. To develop the professional skill on the production of fish and shellfish seeds and hatchery management

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages, and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation, and preparation of extract for injection, dosages, and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carp, mahseer, trout, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea horse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps. Natural seed resources, site selection and collection methods.

Life cycle of important shellfish (*Penaeus monodon, P. indicus, Macrobrachium rosenbergii, P. vannamei, Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe carb, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and Penaeus monodon and *P. vannamei*. Induced maturation in *Penaeus monodon, P. vannamei* and *P. indicus* by eye stalk ablation. Reproductive

physiology. Reproductive hormones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *P. monodon* and *M. rosenbergii*. Breeding and hatchery management of crabs, lobster, mussels, edible and pearl oysters. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practical

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anaesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

Identification of brood stock and maturity stages of important crustaceans and molluscs. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii, Penaeus monodon,* and *P. vannamei*. Identification of larval stages of important crustaceans and molluscs. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and brood stock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/ prawn hatchery.

Suggested readings

1. FAO. 1992. Manual of Seed Production of Carps. FAO Publ.
2. Gupta SD, Mohapatra PC, Routray P, Sahoo SK, Verma DK, Sarangi N. 2008. Textbook of Breeding and Management of Carps. Narendra Publ. House
3. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
4. Jhingran VG and Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
5. Landau M. 1992. Introduction to Aquaculture. John Wiley and Sons.
6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
7. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
8. Thomas PC, Rath SC and Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.
9. Kurian, C.V. and Sebastian, V.O., 1976. Prawns and prawn fisheries of India, Hindustan Pub. Corp., Delhi.
10. CMFRI 2009. Training Manual on Breeding and Larval Rearing of Marine Finfishes and Shellfishes.
11. Diwan AD, Joseph S and Ayyappan S. 2008. Physiology of Reproduction, Breeding and Culture of Tiger Shrimp. Narendra Publ. House
12. FAO 2007. Assessment of Freshwater Fish Seed Resources for Sustainable Aquaculture. FAO Fisheries Technical Paper No. 501.
13. Chakraborty C and Sadhu AK. 2000. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publ. House.

Anatomy and Biology of Fish and Shellfish 3 (2+1)

Objectives

1. To familiarize with the anatomy and biology of fish and shellfish
2. To understand the anatomy and developmental biology of fish and shellfish

Theory

Study of the external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practical

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

Study of Internal Organs commercially important crustaceans and molluscs. Study of Digestive, respiratory, circulatory, nervous, and reproductive systems. Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity, and larval stages.

Suggested readings

1. Barrington EJW. 1981. Invertebrate Structure and Function. 2nd edn. The English Language Book Society and Nelson.
2. Ede DA. 1978. An Introduction to Developmental Biology. Blacki
3. Jobling M. 1995. Environmental Biology of Fishes. Chapman and Hall.
4. Jobling M. 1995. Environmental Biology of Fishes. Springer.
5. Khanna, S.S. and Singh, H.R. 2014. Textbook of Fish Biology and Fisheries. 3rd edn. Narendra Publishing House.
6. Paul, J., Hart, B. and Reynolds, J. D. (Editors), 2002. Handbook of Fish Biology and Fisheries: Fisheries, Volume 2, Blackwell Science Ltd.
7. Ray, Samanta. 2015. Physiology of Finfish and Shellfish.: New Delhi New India Publishing Agency 2015: "xviii, 230p" ISBN: 978-93-83305-68-1

8. Silas EG. 1983. Development of Penaeid Prawns. CMFRI Bull. No. 28.8. Werner A. Muller, 1996. Developmental Biology, Springer. 328p
9. Tembhre, M. 1996. Anatomy and Physiology of Fishes. Vikas Publishing House.
10. Venkataramanujam, K. and Ramanathan, N. 1994. Manual of Finfish Biology. Oxford and IBH publishing Co. Pvt. Ltd 1108.
11. William O. Reece and Rowe, Eric W. 2017. Functional Anatomy and Physiology.

Physiology of Finfish and Shellfish 3 (2+1)

Objectives

1. To understand the physiological function of fish and shellfish
2. To understand concepts in physiology of fish and shellfish

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on the physiology of fish and shellfish. Stress-related physiological changes. Structure and functions of important endocrine glands.

Practical

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbon dioxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques.

Suggested readings

1. Diwan. 2007. Physiology of Marine White Shrimp: *Fenneropenaeus indicus*. Delhi Narendra Publishing House.
2. Evans DH and Claiborne JB. 2006. The Physiology of Fishes. CRC Press.
3. Evans, 2014. Physiology of Fishes. Boca Raton CRC Press 2014, 4th Edition.
4. Hoar WS and Randall DJ.1988. Fish Physiology. Academic Press.
5. Johnston, 2014. Fish Physiology (Series 1-35 volumes) New Delhi Reed Elsevier India Pvt. Ltd.
6. Ray Samanta. 2015. Physiology of Finfish and Shellfish. New Delhi, New India Pub. Agency.
7. Reinecke, 2006. Fish Endocrinology, Vol. 1. Enfield Science Publishers, Inc.
8. Reinecke, 2006. Fish Endocrinology, Vol. 2: Enfield Science Publishers, Inc.
9. Rocha 2008. Fish reproduction. Enfield Science Publishers, Inc.
10. Smith Lynwood S. 1999. Introduction to fish physiology. Narendra Publishing House.

Limnology 2 (1+1)

Objectives

1. To study the limnetic environment
2. To understand the physico-chemical and biological characters of the limnetic environment

Theory

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

Practical

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams, and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

Suggested readings

1. APHA 2017. Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington DC.
2. Bryan M Ham and Aihui MaHam. 2016. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit. Wiley.
3. Claude E Boyd. 1995. Bottom Soils, Sediment, and Pond Aquaculture, Chapman and Hill
4. Cole, G. A. and Weihe, P.E. 2015. Textbook of Limnology, Waveland Pr. Inc.
5. Datta Munshi, J. 2015. Fundamentals of Limnology, Daya Publ. House.
6. Dodds WK. 2002. Freshwater Ecology: Concepts and Environmental Applications. Academic Press, New York.
7. Edmondson WT. 2003. Freshwater Biology. Textbook Publishers, 1248 pp.

8. Essington ME. 2003. Soil and Water Chemistry: An Integrated Approach, CRC Press.
9. Fasset NG. 1997. A Manual of Aquatic Plants. Allied Scientific Publishers, Bikaner.
10. Jose Galizia Tundisi, J.G and Takako Matsumura Tundisi, T.M. 2011. Limnology. CRC Press, London, 888pp.
11. Mitsch WJ. 2009. Wetland Ecosystems. John Wiley and Sons. 295 pp.
12. Nath S. (Ed). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation Vol 7. Narendra Publishing House, New Delhi.
13. Tan KH. 1998. Principles of Soil Chemistry. CRC Press Inc., Boca Raton.
14. Wetzel, R. G. 2010. Limnology. Saunders Publ. 858pp.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide students an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of the establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment–identification of product/service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing knowhow, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages/salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposals for funding by different agencies.

Suggested Readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publl. House.
3. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
6. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
9. Singhal R.K., 2013, Entrepreneurship Development and Management, Katson Books.
10. Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

Environmental Studies and Disaster Management 3 (2+1)

Objective

- To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to windmill/hydropower / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted systems. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disasters.

Suggested Readings

1. De. A.K., 2010. Environmental chemistry. Published by New Age International Publishers, New
2. Dhar Chakrabarti. P.G., 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India 2023. (In Press).
5. Prasanthrajan M, P.P. Mahendran., 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008
6. Prasanthrajan M, 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Personality Development 2(1+1)

Objective

- To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development. 6th edn. Belmont, CA: Wadsworth.

National Cadet Corps (NCC-II) 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill. Characteristics of

rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.

Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defences obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS- II) 1 (0+1)

Objective

- To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs. Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations. Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water-borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-II semester

Internship (only for exit option for award of UG-Certificate) 10 (0+10)

Objectives

1. To make students capable of working in commercial establishments with ground-level knowledge
2. To make students capable of initiating entrepreneurship

Activity

- 10 weeks of intensive training on any aspects of Fisheries.
- The area of training may be in the hatchery, in culture farms or in processing setup to gain basic field-level knowledge to be part of any commercial setup.

SEMESTER-III

Coastal Aquaculture and Mariculture 2 (1+1)

Objectives

1. To gain knowledge on the culture of coastal and marine fish and shell-fish species
2. To acquire knowledge of coastal marine farming of fish and shell-fish

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearl spot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster). Seaweed culture. Seed resources. Shore-based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi-intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture: rafts, racks, cages, poles, and ropes. Water and soil quality management. Estimation of growth, survival, and pond productivity. Pearl culture. Sea ranching.

Practical

Identification of important cultivable species. Collection and identification of commercially important seeds of fish and shellfish. Types of fertilizers - Pond preparation. Seed selection, quality, and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

Suggested readings

1. Appukuttan KK, Asokan PK, Mohamed KS, Subramaniam S and G Joseph GK. 2003. Manual on Mussel Farming. CMFRI Technical Bulletin 3.
2. Bardach EJ, Rhyther JH and Mc Larney WO. 1972. Aquaculture the Farming and Husbandry of Freshwater and Marine Organisms. John Wiley and Sons.
3. De Silva S.S. (Ed.)., 1998. Tropical Mariculture, Academic Press, 487p.
4. FAO. 2001. Planning and Management for Sustainable Coastal Aquaculture Development.
5. Ghosh, P.K. 2010. Brackishwater Aquaculture. Agrobios (India)
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14. Syda Rao G, Imelda-Joseph, Philipose KK and Suresh Kumar M, 2013. Cage aquaculture in India. CMFRI Publ
15. Venugopal S. 2005. Aquaculture. Pointer Publ.

Fish Nutrition and Feed Technology 3 (2+1)

Objectives

1. To understand the basic principles of fish nutrition and the role of different nutrients
2. To learn the process of feed formulation and preparation for fish and shell-fish

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.

Practical

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Formulation and preparation of moist feed by using locally available ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality. Estimation of the gross energy content of feed. Estimation of the digestible energy content of the feed. Equipments and machineries used in feed production. Visit to commercial feed plant.

Suggested readings

1. ADCP (Aquaculture Development and Co-ordination Program). 1980. Fish Feed Technology, ADCP/REP/80/11. FAO., Rome.
2. De Silva, S. S. and Anderson, T. A. 1995. Fish Nutrition in Aquaculture, Chapman and Hall Aquaculture Series, London.
3. FAO training manual related to feed analysis.
4. Guillame, J., Kaushik, S., Berqot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans, Springer Praxis Publishing, Chichester, U.K.

5. Halver J. E. 1989. Fish Nutrition, Academic Press, San Diego, California.
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10. New, M.B. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. ADCP/REP/87/26 F.A.O. Rome.
11. Paulraj, R., 1993. Aquaculture Feed. CMFRI publication, 84 pp.

Inland Fisheries 2 (1+1)

Objectives

1. To understand the present exploitation and future potential of inland fisheries
2. To learn the methodologies for assessments of inland fisheries resources

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to the respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery- present status of their exploitation and future prospects. Cold water fisheries of India.

Practical

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, floodplain wetlands, coldwater bodies, net making yards.

Suggested readings

1. Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries. Chapman and Hall.
2. FAO. Technical Papers on Freshwater Fisheries.
2. Jeppe Kolding, Upali S. Amarasinghe, Jane Turpie, R., Brummett, Patrick Dugan, Pradeep Katiha 2021. Inland fisheries and Aquaculture.
3. Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.
4. Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.

5. Jhingran VG. 1991. Fish and Fisheries of India. 3rd edn. Hindustan Publ.
6. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House.
7. Ayyappan S., Moza, Usha, Gopalakrishnan, A., Meenakumari, B., Jena, J.K., Pandey, A.K. (2nd edn). 2011. Handbook of Fisheries and Aquaculture, ICAR: 1116.
8. Chandra P. 2007. Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India. Daya Publ. House.
9. FAO. Technical Papers on Freshwater Fisheries.
10. Handbook on Fisheries Statistics. 2022. Dept. of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India, New Delhi.
11. Jain V., Sinha R., Singh L. P. and Tandon S. K. 2016. River Systems in India: The Anthropocene Context, Proc Indian Natn Sci Acad 82 No. 3 July Spl Issue 2016 pp. 747-761
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13. Vishwas B. Sakhara. 2013. Inland Fisheries. Daya Publishing House.
14. Welcomme, R.L. 2001. Inland Fisheries – Ecology and Management. Wiley-Blackwell; 1st edn, UK.

Fishing Craft Technology 2 (1+1)

Objectives

1. To teach advanced aspects of fishing craft design
2. To learn about modification of existing craft layout

Theory

Introduction: History and development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History and development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of the longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance of fishing vessels. Fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

Practical

Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing. Drawing of back bone assembly. U and V bottom hull of wooden boat.

General view of boat; Drawing of sheer plan, body plan and half breadth plan. Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

Suggested readings

1. Fyson JF. (ed). 1985. Design of Small Fishing Vessels, Fishing News Books, Oxford.
2. Pike D. 1992. Fishing Boats and Their Equipment. Fishing News Books. Oxford: 184p.
3. Ponnambalam A. 2003. Fishing Craft Technology. CIFNET. Cochin: 158p.
4. Sanisbury JC. 1996. Commercial Fishing Methods-an Introduction to Vessels and Gear, Fishing News Books Ltd., Farnham, 352p.
5. Shenoy Latha. 1988. Course Manual in Fishing Technology, CIFE, Mumbai, 95p.
6. Sreekrishna Y and Shenoy Latha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research, New Delhi, 342p.
7. Yadav YS. 2002. Traditional Fishing Craft of the Bay of Bengal. BOBP. Chennai: 55p

Fundamentals of Biochemistry and Food Chemistry 3 (2+1)

Objectives

1. To create basic understanding on biochemical constituents of food fish and shell-fish
2. To develop skills on the analysis of chemical constituents in food

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Structure, classification and functions of carbohydrate. Isomerism and mutarotation. Metabolism of carbohydrates: Glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic.

Lipids: Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids.

Proteins: Classification, structure, function and properties of proteins. Essential and non-essential amino acids. Biuret reaction and xanthoproteic reaction of protein detection. Metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing. Texturized proteins.

Enzymes: Nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones: Chemistry and function. Vitamins and Minerals: Classification and functions. Structure and functions of fat and water-soluble vitamins. Minerals: Classification and functions minerals. Nucleic acids: Structure and function. Importance of genetic code.

Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

Practical

Preparation of normal solution of acid and base, buffers and reagents. Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Estimation of carbohydrates in foods. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods. Determination of specific gravity of oil. Determination of saponification value, iodine value and free fatty acid value.

Suggested readings

1. Ashrust PR. 1999. Food Flavourings. 3rd edn. Aspen Publ.
2. Belitz HD and Grosch W. 1999. Food Chemistry. 2nd Ed. Springer.
3. Berg JM, Tymoczko JL and Stryer L. 2002. Biochemistry. W.H. Freeman and Company.
4. H A Modi. 2012. Food additives. Aavishkar Publishers Distributors (Jaipur)
5. Hutching JB. 1999. Food Colour and Appearance. 2nd Ed. Aspen Publ.
6. Keith Wilson, John Walker, 2013. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (New York).
7. Michael J. Scotter. 2015. Colour Additives for Foods and Beverage. Woodhead Publishing Limited (Oxford).
8. Murray RK, Granner DK, Mayes PA and Rodwell VW. 2000. Harper's Biochemistry. Appleton and Lange
9. NIIR Board. Food colours, flavours and additives technology hand book. National Institute of Industrial Research (Delhi).
10. Samantaray, K. Principles of Biochemistry (with special reference to fishes). Narendra Publishing House
11. Semih Otles. 2012. Methods of Analysis of Food Components and Additives. CRC Press (Boca Raton).
12. Teranishi R, Buttery RG and Shahidi F. 1989. Flavour Chemistry – Trends and Developments. American Chemical Society, Washington D.C
13. Voet D, Voet JG and Pratt CW. 2006. Fundamentals of Biochemistry. John Wiley and Sons, Inc
14. Wilson K and Walker J. 1995. Principles and Techniques of Practical Biochemistry. Cambridge University Press.

Post-Harvest Handling and Preservation 2 (1+1)

Objectives

1. To teach scientific techniques of handling, storage and transport of fresh fish
2. To teach various post-harvest changes during chill storage of fish

Theory

Structure of fish myosystems, Postmortem changes - Structural and chemical. Fish as raw material for processing: Body structure, physical properties, shape, specific weight, bulk weight, angle of slip, weight composition. Factors affecting quality of fresh fish: intrinsic and extrinsic factors. Handling of fish onboard fishing vessels, Unit operations. Unloading fish, Fish pumps. Post-harvest Fishery losses, Methods to reduce losses. Handling of fish in landing centers, defects and modifications needed. Chill storage of fish: Heat load calculation, storage methods. Insulated boxes and insulation thickness, different types of ice, physical, chemical, microbiological and sensory changes during chill storage, iced storage shelf life, cold shock, physical, chemical and sensory methods of analysis. Different types of ice and their advantages. Melanosis and its prevention, discolouration in aquatic products, nonenzymatic browning. Depuration of bivalves. Transportation: Live fish/shell fish, Transportation of raw fish to local markets and processing centres, Improvements needed in transportation, Refrigerated transport systems. Classification of transport vehicles. Cold chain.

Practical

Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. Handling of fish, bivalves, prawns, molluscs, Depuration, treatment with chemicals, evaluation of freshness of fish.

Suggested Readings

1. Aitken A, Mackie M, Merritt SH & and Windsor ML. 1982. Fish Handling and Processing.
2. Anon. 1965. Fish Handling and Preservation. Proc. Meeting on Fish Technology.,
3. Balachandran KK. 2001. Post Harvest Technology of Fish and Fish Products. Daya Publ.
4. Connell JJ. 1980. Advances in Fish Sciences and Technology. Farnhan Surrey.
5. George MH. 1992. Fish Processing Technology. VCH Publ.
6. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
7. Ministry of Agriculture, Fisheries and Food, Edinburgh.
8. Scheveningen. Organisation for Economic Co-operation and Development, Paris.
9. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.

Fisheries Extension 2(1+1)

Objectives

1. To help the students to appreciate the process of extension education
2. To cater the need of equipping the scholars with essential skills

Theory

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education. History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process. Important ToT programs in fisheries; role of NGOs and SHGs in fisheries. Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in the diffusion of fisheries innovations. Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries. Theories of learning, learning experience, learning situation.

Practical

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques. Stakeholders' analysis and needs assessment. Assessment of development needs of community and role of formal and non – governmental organizations through stakeholders' analysis. Case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

Suggested readings

1. Adhikarya R. 1994. Strategic Extension Campaign – A Participatory-Oriented Method of Agricultural Extension.
2. Agarwal B. 1986. Women, Poverty and Agricultural Growth in India, JPS, New Delhi.
3. Antholt C and Zijp W. 1994. Participation in Agricultural Extension. Washington, DC: The World Bank
4. Berdegue JA and Escobar G. 2001. Agricultural Knowledge and Information Systems and Poverty Reduction. AKIS Discussion Paper. Washington, DC: The World Bank.
5. Bhasin K. Understanding Gender, New Delhi, Kali for Women, 2000
6. Birner R and Anderson JR. 2007. How to Make Agricultural Extension Demand Driven–The Case of India's Agricultural Extension Policy. IFPRI Discussion Paper. International Food Policy Research Institute. Washington, DC: IFPRI
7. Daivadeenam P. 2002. Research Methodology in Extension Education. Agro-Tech Publ. Academy.
8. Kerlinger N Fred. 2002. Foundations of Behavioural Research. Surjeet Publ.
9. Menon Nivedita. 1999. Gender and Politics in India, New Delhi: Oxford.
10. Patricia Uberoi. 2009. Freedom and Destiny: Gender, Family, and Popular Culture in India, Oxford University Press, New Delhi
11. Ray GL and Mondal S. 1999. Research Methods in Social Science and Extension Education. Naya Prokash.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first-aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Swimming: History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke). Competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving-styles of diving, rules, regulations, and precautions. Methods of life saving in water; Boating, canoeing, and sailing: types, maintenance, skill development, rules and regulations and practice. Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques. First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid

related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with the Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

SEMESTER-IV

Breeding and Culture of Ornamental Fish 2 (1+1)

Objectives

1. To gain knowledge on ornamental fish production technologies and aquarium building
2. To produce ornamental fish for marketing

Theory

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filtration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport, and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

Practical

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

Suggested readings

1. Ahilan, B., Felix, N., and Santhanam, R. 2008. Textbook of Aquariculture. Daya Publishing House, Delhi.
2. Axelrod HR and Sweenen ME. 1992. The Fascination of Breeding Aquarium Fishes. TFH Publ.
3. Axelrod HR and Vorderwinkler W. 1978. Encyclopaedia of Tropical Fishes. TFH Publ.
4. Axelrod HR. 1967. Breeding Aquarium Fishes. TFH Publ.
5. Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn
6. Crow R. and Keeley D. 1992. A Practical Guide to Tropical Aquarium Fish. Tiger Book Int., London.
7. Mills D. 1981. Aquarium Fishes. Kingfisher Books.
8. Sanford G and Crow R. 1991. The Manual of Tank Busters. Salamander Books.
9. Saxena A. (Ed.). 2003. Aquarium Management. Daya Publ.

10. Spotte S. 1979. Fish and Invertebrate Culture. John Wiley and Sons.
11. Swain S.K., Sarangi, N. and Ayyappan, S. 2010. Ornamental Fish Farming. ICAR.
12. Thabrow De WV. 1981. Popular Aquarium Plants. Thornbill Press
13. Thomas PC, Rath SC and Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.

Live Food Organisms for Fish and Shellfish 2 (1+1)

Objectives

1. To learn the nutritional requirements of fish and shell-fish larvae
2. Techniques the culture of live food organisms from fish and shell-fish larvae

Theory

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

Practical

Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Proximate composition analysis of live feed organisms. Decapsulation and hatching method of brine shrimp cyst.

Suggested readings

1. CIFE. 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.
2. Gopinathan CP. 1993. Handbook on Aqua Farming - Live Feed. MPEDA Publication
3. Hagiwara A, Snell TW, Lubzens E and Tamaru CS. 1997. Live Food in Aquaculture. Proceedings of the Live Food and Marine Larviculture Symposium. Kluwer.
4. Joan Holt G. 2011. Larval fish nutrition. Wiley Blackwell Publ.
5. Lavens P and Sorgeloos P. (eds.). 1996. Manual on the production and use of live food for aquaculture. FAO Fisheries Technical Paper. No. 361. Rome, FAO, 295pp.
6. Lee CS., O'Bryen, PJ, Marcus NH. 2005. Copepods in aquaculture. Blackwell Publishing.
7. Mamta Rawat, Sumit Dookia. 2012. Biodiversity of Aquatic Resources. Day.
8. MPEDA. 1993. Handbook on Aqua Farming - Live Feed. Micro Algal Culture. MPEDA Publication.
9. Muthu MS. 1983. Culture of Live Feed Organisms. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.
10. Sorgeloos P and Pandian KS. 1984. Culture of Live Food Organisms with Special Reference to Artemia Culture. CMFRI Spl. Publ. No. 15.

Fish and Shellfish Diseases and Treatment 3 (2+1)

Objectives

1. To understand the recent advances in diseases of fish and shell-fish and their remedial measures
2. Fish and Shellfish disease diagnosis and treatment

Theory

General characteristics, life cycle, diagnosis of pathogens. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Bioremediators, Biocontrol agents, Probiotics, Immunomodulators, Concepts of vaccination. Shrimp toilet. Management measures for the host. Specific pathogen-free (SPF), Specific pathogen-resistant (SPR) and Specific pathogen-tolerant (SPT). Developing management practices and biosecurity principles: Health maintenance, Better management practices (BMP), Good aquaculture practices (GAP), Hazard analysis and Critical control point (HACCP) and Biosecurity principles in aquaculture.

Disease control through environmental management: Importance of Biofilm and Bio-floc. Periphyton in aquatic health management. Zoonotic diseases. Principles of disease diagnosis: Conventional, molecular and antibody-based diagnostic methods. Rapid diagnostic methods.

Practical

General procedure for disease diagnosis. Methods of fish and shell-fish sampling for disease diagnosis. Taxonomy, lifecycle and identification of fish and shell-fish parasites. Sampling, preparation of media and culture of pathogenic bacteria. Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, histopathological, immunological, molecular techniques and biochemical tests. Agglutination test and Challenge tests; Purification of virus. Stress-related study of fish and shell-fish. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shell-fish.

Suggested readings

1. Alan C. 2005. Molecular Virology. Academic Press 315 p.
2. Austin B and Austin A. 2007. Bacterial Fish Pathogens. Springer Publishers, U.K.
3. Bullock LG. 2014. Diseases of Fishes. NPH, Delhi
4. Cox FEG. 2005. Parasitology. Hodder Arnold. U.S.A.
5. Crosa JH. 1983. Bacterial and Viral Diseases of Fish. Washington Sea Grant Publication, Seattle.
6. Gupta N. 2014. Modern Parasitology. Narendra Publishing House, Delhi
7. Hadwin G. 2017. Diseases of Fishes. Bacterial Diseases of Fishes and Identification of Fish Pathogenic Bacteria. Random Pub., New Delhi.
8. Iglewski HB and Clark VL. 1009. Molecular Basis of Bacterial Pathogenicity. Academic Press.
9. Inglis V. 1993. Bacterial Diseases of Fish. Blackwell Scientific Publications, London.
10. Roberts RJ. 2012. Fish Pathology. 4th Ed. W.B. Saunders.

Marine Fisheries 2 (1+1)

Objectives

1. To understand the present exploitation and future potential of marine fisheries
2. To learn the methodologies for assessments of marine fisheries resources

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic, demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of India's EEZ. GIS and Remote sensing in marine capture fishery. Conservation and management of marine fisheries resources in India.

Practical

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

Suggested readings

1. Blaber, J.M. 1997. Fish and Fisheries in Tropical Estuaries. Chapman and Hall.
2. Bal, D.V. and Rao, K.V. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.
3. Chandra, P. 2007. Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India. Daya Publ. House.
4. FAO. Technical Papers on Marine Fisheries.
5. Kurian, C.V. and Sebastian, V.O. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
6. Alok Kumar Upadhyay and Joshi, B C . 2014: Textbook of Marine Fisheries: Fisheries of World Oceans and India in Perspective. Astral International Private Limited: 232 p.
7. Mohan Joseph, M. and Pillai, N. G. K. eds 2007: Status and Perspectives in Marine Fisheries Research in India, CMFRI.

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Fishing and Gear Technology 3 (2+1)

Objectives

1. To teach advanced fishing gear and fishing technology
2. To learn design modification and gear selectivity of fishing

Theory

Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear, methods of the world and International Standard Statistical Classification of Fishing gear (ISSCFG). Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order. Construction of ropes and their higher order. Construction of braided netting twines. Yarn numbering system - direct system: Tex system, Denier system and calculation of resultant tex value. Indirect system: British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond, square, hexagonal and their measurement. Properties of netting material: physical properties- Density, twist and amount of twist, breaking strength-tenacity, and tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption and shrinkage, sinking velocity, weather resistance, melting point and visibility. Chemical and Biological properties. Floats and buoys – its materials, types their properties. Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation. Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear. Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board.

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gear arrangements. Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid-water trawling. Constructional details of single-boat purse seine; two-boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid-water and pelagic gillnetting.

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole and line and trolling line. Operation of long line: set and drift

long lining: bottom, mid-water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch-reducing devices. Deck equipment – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practical

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step. Tailoring method: T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination. Joining of net pieces. Net mounting – hanging coefficient, hung depth and their calculation. Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques.

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook and line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Suggested readings

1. Ben-Yami M. 1994. Purse seining manual, FAO Fishing manual, 416p.
2. Biswas KP. 1996. Harvesting Aquatic Resources. Daya Publishing House – Delhi: 207 p.
3. Bjordal and Lokkeborg S. 1998. Long Lining, Fishing News Books Ltd. Farnham, 208p.
4. Brandt AV. 1984. Fish Catching Methods of the World. Fishing news books Ltd., London, 432p.
5. FAO. 1987. Small Scale Fishing Gear: 19 – 44pp.
6. FAO. 1996. Fishing Operations, FAO Training Guidelines for responsible fisheries No.1, FAO, Rome 26p
7. Fridman AL. 1986. Calculations for Fishing Gear Designs, FAO Fishing manual, Fishing News Books, Ltd., Farnham, 264p.
8. Kristionsson H. 1975. Modern Fishing Gear of the World. The White Friars Press Limited. London: 594 p.
9. Sreekrishna Y and Shenoy Latha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research. New Delhi, 342p

Fish Products, By-products, Value Addition and Waste Management 3 (2+1)

Objectives

1. To understand the concepts of fish products and by-products
2. To teach concepts of value addition of fish products and waste management

Theory

Principle of fish preservation and processing. Processing of fish by traditional methods– salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting– wet salting and dry salting. Drying and dehydration- theory, importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt-cured fish. Quality standard for salted and dry fish.

Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. Methods of smoking and equipment used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing. Marinated and fermented fish products–role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibrillar protein and their role in elasticity formation. Extruded products: theory of extrusion, equipment used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. HACCP in safe product production. Fish meal: dry reduction and wet reduction methods, specification, packaging and storage. Fish oil: body oil, liver oil extraction, purification, preservation, storage, and application. Shrimp wastes: chitin, chitosan production, uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish silage, acid silage, fermented silage and their application. Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practical

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn and fish pickles. Preparation of fermented fish sauce and marinade products. Preparation of surimi and surimi-based products. Preparation of diversified and value-added fish products. Quality assessment of market sample of dried and fermented fish products.

Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure. Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

Suggested readings

1. Balachandran KK. 2001. Post-Harvest Technology of Fish and Fish Products. Daya Publ.
2. Elvevoll EO. Fish Waste and Functional foods, Norwegian College of Fishery Science, Department of Marine Biotechnology, Norway. edele@nfh.uit.no
3. Fereidoon Shahidi. 2007. Maximizing the Value of Marine By-Products, CRC Press Inc. (Florida)
4. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
5. Hall GM. (Ed.). 1992. Fish Processing Technology. Blackie.
6. Nambudiri DD. 2006. Technology of Fishery Products. Fishing Chimes.
7. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.
8. T Borresen 2008, Improving Seafood Products for the Consumer, Woodhead Publishing Limited (Cambridge)
9. Venugopal V. 2005. Seafood Processing: Adding Value Through Quick Freezing Retort Packaging, and Cook-Chilling, Taylor and Francis (Boca Raton).
10. Wheaton FW and Lawson TB. 1985. Processing Aquatic Food Products. John Wiley and Sons.

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Government in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with agricultural-informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc.

Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation

of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands. Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS-EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands-on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Database Management System by C. J. Date.
4. Introduction to Information Technology. Pearson.
5. Introductory Agri-Informatics. Mahapatra, Subrat K et al., Jain Brothers Publication.

Post-IV semester

Internship (only for exit option for award of UG-Diploma) 10 (0+10)

General objective

1. To make students capable of working in the commercial establishments as a supervising or management staff
2. To make students capable of being an entrepreneur

Activity

- 10 weeks of intensive training on any aspects of Fisheries will help in broadening career aspects
- The area of training may be in the hatchery, in culture farms or in processing industries

SEMESTER-V

Fish Genetics and Breeding 2 (1+1)

Objectives

1. To understand the basic principles of genetics and breeding and their application to fisheries
2. To improve the quality and quantity of fish and shell-fish species

Theory

Principles of genetics and breeding. Gene and chromosome as basis of inheritance. Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex-influenced and sex-limited traits. Linkage and crossing over. Introduction to population genetics. Hardy - Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross-breeding, heterosis and design of cross-breeding programs, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practical

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Estimation of inbreeding coefficient. Preparation of Selection index for the selective breeding program. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt. Study of risk factors in cryopreservation technique.

Suggested readings

1. Ayyappan S. 2004. Fisheries Biotechnology. Narendra Publ. House.
2. Gjedrem Trygve et al. 2005. Selection and Breeding Programs in Aquaculture. Springer.
3. Kirpichnikov VS. 1981. Genetic Basis of Fish Selection. Springer-Verlag.
4. Lakra WS, Abidi SAH, Mukherjee SC and Lutz CG. 2003. Practical Genetics for Aquaculture. Wiley-Blackwell.
5. Lutz CG. 2003. Practical Genetics for Aquaculture. Wiley-Blackwell.
6. Lynch M and Walsh B. 1997. Genetics and Analysis of Quantitative Traits. Sinauer, Sunderland.
7. Nagabhushanam R, Diwan AD, Zahurnec BJ and Sarojini R. 2004. Biotechnology of Aquatic Animals. Science Publ.
8. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
9. Purdom CE. 1993. Genetics and Fish Breeding. Chapman and Hall.

10. Snustad DP and Simmons MJ. 1999. Principles of Genetics. 2nd edn. John Wiley and Sons.
11. Stansfield WD. 1991. Theory and Problems of Genetics. McGraw-Hill.
12. Tave D. 1993. Genetics for Fish Hatchery Managers. 2nd edn. Chapman and Hall.

Marine Biology 2 (1+1)

Objectives

1. To understand the Marine life and its biology
2. To study the diversity of marine organism

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, zooplankton and seaweeds. Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonation, communities, and the adaptation. Mud banks: formation and characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species. Blooms, Red tides: cause and effects.

Practical

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, seaweeds and inter tidal organisms.

Suggested readings

1. Cass-Dudley, V. L., Dudley G. and Sumich, J.L. 2016. Laboratory and Field Investigations in Marine Life. 11th edn, Jones and Bartlett Learning.
2. Castro, P. and Huber, M.E. 2018. Marine Biology, McGraw Hill.
3. Derek Burton, D. and Burton, M. 2017. Essential Fish Biology: Diversity, structure, and function, Oxford University Press.
4. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
5. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
6. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
7. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
8. Pond S and Pickard GL. 2013. Introductory Dynamical Oceanography. Elsevier
9. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.

Fish Population Dynamics and Stock Assessment 2 (1+1)

Objectives

1. To understand the stock concept and principles of fisheries management
2. To understand the application of various models and their applications in fisheries management

Theory

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

Practical

Study of length – weight relationship, segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. Estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

Suggested readings

1. Callucci VG, Saila SB, Gustafson DJ and Rothschild BJ. 1996. Stock Assessment. Quantitative methods and applications for small scale fisheries. Lewis publishers. Boca Raton, P. 527.
2. Devaraj M. 1983. Fish Population dynamics: a course manual, CIFE Bulletin 3 (10): 98p
3. Gulland JA. 1977. Fish population dynamics. John-wiley and sons. Chichester. P. 422.
4. Gulland JA. 1992. A review of length-based approaches to assessing fish stocks. FAO technical paper. 323. p.100.
5. Hilborn R and CJ Walters. 1992. Quantitative Fisheries Stock Assessment – Choice, Dynamics and Uncertainty. Pub. Chapman and Hall. 570p.
6. Pauly D. 1980. Selection of simple methods for the assessment of tropical fish stocks. FAO Fish. Circ., (729): 54p.
7. Quinn TJ and RB Deriso. 2003. Quantitative fish dynamics. Pub. Academic Press.
8. Ricker WE. 1971. Methods for the Assessment of Fish Production in Freshwaters. Blackwell, Oxford and IBH.
9. Sparre P and Venema SC. 1998. Introduction to Tropical Fish Stock Assessment. Part 1 Manual. FAO. Fisheries Tech. Paper No.301, Rome
10. Vivekanandan E. 2005. Stock assessment of tropical marine fishes. Indian Council of Agricultural Research, New Delhi.

Aquatic Ecology and Biodiversity 2 (1+1)

Objectives

1. To enrich the knowledge on the ecology and biodiversity of aquatic environment
2. To assess the threats on the ecosystem and biodiversity of aquatic environment

Theory

Aquatic environment, Flora and fauna: Components of aquatic systems. Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destruction, introduction of exotic species. Conservation of habitats: marine parks and sanctuaries. Conservation programs for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Practical

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Collection, identification, and preservation of mangrove plants. Working out biodiversity indices.

Suggested readings

1. Andy D Ward, Stanley W Trimble, Suzette R Burckhard and John G Lyon. 2015. Environmental Hydrology, CRC press.
2. Barnes RSK and Mann KH. eds. 2009. Fundamentals of aquatic ecology. John Wiley and Sons.
3. Carter RWG. 1998. Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. Academic Press, London.
4. Dodds W and Whiles M. 2010. Freshwater Ecology, 2nd edn, Concepts and Environmental Application of Limnology. Academic Press, London.
5. Dodds WK. 2002. Freshwater Ecology: Concepts and Environmental Applications. Academic Press, New York.
6. Elliott A. Norse (Ed.) 1993. Global marine Biological Diversity. Inland press, Washington, D.C.383p.
7. Khanna DR, Chopra AK and Prasad G. 2005. Aquatic Biodiversity in India. Daya Publ. House.
8. Kormondy EJ. 1986. Concepts of Ecology, Prentice-Hall, New Delhi.
9. Kumar U and Asija MJ. 2000. Biodiversity Principles and Conservation. Agrobios.
10. Magurran AE. 1988. Ecological Diversity and its Measurement. Taylor and Francis.
11. Menon AGK. 2004. Threatened Fishes of India and their Conservation. Fisheries Survey of India.

12. Mitsch WJ. 2009. Wetland Ecosystems. John Wiley and Sons. 295 pp
13. Nath S. (Ed). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation Vol 7. Narendra Publishing House, New Delhi
14. Okuda N, Watanabe K, Fukumori K, Nakano SI and Nakazawa T. 2014. Biodiversity in aquatic systems and environments: Lake Biwa. Springer Japan.
15. Thorpe JE, Talbot C and Miles MS. (Ed.) 1995. Conservation of Fish and Shell Fish Resource; Managing Diversity. Academic Press.

Pharmacology and Toxicology 3 (2+1)

Objectives

1. To understand the application and impact of aquaculture drugs and chemicals in fisheries
2. To impart knowledge on the toxicity of drugs and chemicals on aquaculture and fisheries

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs. Pharmacotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation, and excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non-receptor mediated action. Dose Response Relationship, half-life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transportation. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry.

General Toxicology: Definitions, Branches of Toxicology, Historical developments, Classification and types of poison. Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetic, Toxicodynamic, General approaches to diagnosis and treatment of poisoning.

Systemic Toxicology: Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases. Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish. Metabolism of toxic substances by aquatic organisms.

Practical

Metrology, Prescription Writing, Preparation of drug solution, Source and chemical nature of drugs. Incompatibility, Pharmaceutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish.

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe^{3+}), Copper (Cu), Ammonia,

Ammonium (NH_4^+), Chloride (Cl^-), Phosphate (PO_4^{2-}) Sulphate (SO_4^{2-}), Fluoride (Fl^-). Qualitative detection of Nitrite and Nitrate. Detection of hydrocyanic acid. Detection and Estimation of Mycotoxins. Test for detection of alkaloids. Estimation of LD_{50} and ED_{50}. Demonstration of drug toxicity.

Suggested readings

1. Aquatic Toxicology. American Society for Testing and Materials, Philadelphia 1980.
2. Brown KM. 2000. Applied Fish Pharmacology. Kluwer Academic Press, London.
3. Derelanko MJ. 1995. CRC Handbook of Toxicology. CRC Press, Boca Raton.
4. Hayes AW. 2008. Principles and Methods of Toxicology. CRC Press, U.S.A.
5. Herwig N. 1979. Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases. Charles C Thomas, Springfield.
6. Hoboken NJ. 2010. A Textbook of Modern Toxicology. John Wiley and Sons.
7. Hyde W et al. 1977. Analytical Toxicology Methods Manual. IOWA State University Press, Ames.
8. Kram DJ. 2001. Toxicology Testing Handbook. Marcel Dekker, Inc., New York.
9. Malins DC. 1994. Aquatic Toxicology. Lewis Publishers, Boca Raton.
10. Metelev VV. 1983. Water Toxicology. Amerind Publishing Co Pvt Ltd, New Delhi.
11. Niesink RJM. 1996. Toxicology Principles and Applications. CRC Press, New York.
12. Pandey BN. 2011. Fisheries and Fish Toxicology. A P H Publishing Corporation, New Delhi
13. Pandey G. 2017. Fish Pharmacology and Toxicology. DPH, New Delhi.
14. Radostits M. 2000. Veterinary Medicine. Book power Publisher, China.
15. Rand GM. 1985. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corporation, Washington.
16. Singh ISB. 2003. Aquaculture Medicine. Cochin University 2003. 336p.
17. Stockopf MK. 1993. Fish Medicine. W.B. Saunders Company, London.
18. The Toxicology of Fishes. CRC Press, Boca Raton, 2008.

Fish Freezing Technology 2 (1+1)

Objectives

1. To gain knowledge on the mechanism of action of chilling and freezing methods for preservation of fish and shell-fish
2. To understand the mechanism of the freezing technology for preservation

Theory

Introduction to freezing technology; characteristics of fish and shellfish. Changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. Principles of low temperature preservations. Chilling of fish: methods and equipment for chilling; icing: quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish: fundamental

aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico–chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish and shellfish for freezing. Changes that occur during frozen storage: microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments: polyphosphate, glazing, antioxidants, packaging; thawing of frozen fish and shellfish: methods of thawing. Transportation of frozen fish and shellfish, cold chain, quality control, HACCP in freezing industry.

Practical

Sanitation and plant housekeeping. Chilling and freezing equipment, instruments. Packages and product styles. Methods of icing fish; cooling rate. Preservation by chilled sea water; freezing and thawing curves. Freezing of different varieties of fish and shellfish; estimation of drip. Determination of quality changes during frozen storage. Inspection of frozen fishery products. Visits to ice plants, cold storages, and freezing plants.

Suggested readings

1. AOAC manual
2. Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
3. Clucas IJ. 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO.
4. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
5. SEAFDEC manual
6. Nalan Gokoglu, Pinar Yerlikaya. 2015. Seafood Chilling, Refrigeration and Freezing: Science and Technology, John Wiley and Sons (Chichester)
7. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.
8. Venugopal V. 2006. Seafood Processing. Taylor and Francis.

Fish Canning Technology and Packaging 2 (1+1)

Objectives

1. To provide information on various aspects of thermal / heat processing, fish packaging materials, their appropriate use and benefits
2. To impart knowledge on canning technology, packaging and labeling

Theory

Fish Canning Technology: Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, absolute sterility, pasteurization and sterilization. Canning process: Process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of microorganisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Process calculation by

general/ graphical methods. Estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept. Canning of commercially important fin fishes, shellfishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal.

Packaging: Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use; Protective packaging with special reference to food. Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. Principles of packaging: fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging, Modified Atmosphere Packaging (MAP). Polymeric Packaging. Packaging requirements of fresh fish, frozen fish, canned fish. Transport worthiness of packaging materials, accelerated shelf testing. Safety and legislation aspects of packaging. Labelling and bar coding.

Practical

Types of cans, canning equipment and layout of cannery. Canning of different varieties of fish and shellfish. Cutout test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

Suggested readings

1. Akhil Mathur. 2012. Food Processing, Packaging, Labelling and Marketing. Anmol Publications Pvt. Ltd. (New Delhi)
2. Da-Wen Sun 2005, Thermal Food Processing: New Technologies and Quality Issues, Taylor and Francis (Boca Raton)
3. Gopakumar K. 1993. Fish Packaging Technology - Materials and Methods. Concept Publ.
4. Gordon L Robertson. 2005. Food Packaging: Principles and Practices, "Marcel Dekker, Inc." (New York)
5. Hall GM. (Ed). 1992. Fish Processing Technology. Blackie.
6. Hersom AC and Hulland ED. 1980. Canned Foods. Chemical Publ. Co.
7. Jerry D'Souza, Jatin Pradhan. 2010. Handbook of Food Processing Packaging and Labeling, SBS Publishers and Distributors Pvt. Ltd. (New Delhi)

8. Larousse J and Brown BE. 1997. Food Canning Technology. Wiley VCH.
9. Ponnuswami V. 2012. Nano Food Packaging: A New Post-Harvest Venture, Narendra Publishing House (Delhi)
10. Srinivasa Gopal, TK. 2007. Seafood Packaging, Central Institute of Fisheries Technology (Cochin).
11. Subasinghe S. 1999. Retail Packaging of Fish and Fishery Products, Info Fish.
12. Venugopal V. 2006. Seafood Processing. Taylor and Francis.
13. Warne D. 1988. Manual on Fish Canning. FAO Fisheries Tech. Paper 285.
14. Zeathen P. 1984. Thermal Processing and Quality of Foods. Elsevier.
15. Holdsworth SD. 1997. Thermal Processing of Packaged Foods, Blackie Academic and Professional.

Aquaculture Engineering 3 (2+1)

Objectives

1. To acquire the knowledge of land survey, excavation of ponds, design and lay-out of fish/prawn farms.
2. To understand the basic knowledge for the construction of Finfish and Shellfish farms and hatcheries.

Theory

Fish Farm: Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm: site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics. Land Surveying: definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due to the incorrect chain length. Chain surveying: definition, instruments used for setting out right angles, basic problems in chaining, cross-staff survey. Compass surveying: definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Levelling: definitions, methods of levelling, levelling instruments, terms and abbreviations, types of spirit levelling. Plane table surveying: instruments required, working operation, methods. Contour surveying: definition, contour interval, characteristics of contour, contouring methods and uses of contour. Soil and its properties: classification of soil; soil sampling methods; three-phase system of soil, definitions of soil properties and permeability of soil. Ponds: classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish pond: layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds. Types of ponds: nursery ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond etc., construction ponds, marking, excavation. Dykes: types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes. Water distribution system: canal, types of canals; feeder canal, diversion canal etc., Pipe line system. Water control structures: types of inlets and outlets and their construction. Water budget equation. Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms: tide-fed, pump-fed

farms. Hatcheries: Site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries: brood stock ponds, artemia hatching tanks, sheds etc. Raceway culture system: site selection, layout plan, types of raceway culture system viz., parallel system, series system etc., Aerators: principles, classification of aerators and placement of aerators. Pumps: purpose of pumping, types, selection of pump, total head, horse power calculation. Filters: types and constructions.

Practical

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculations. Visit to different types of farms.

Suggested readings

1. Bose, A.N. Ghosh, S. N., Yang, C.T. and Mitra, A. 2009. Coastal Aquaculture Engineering, Cambridge University Press.
2. Mishra, R. and Dora, K.C. 2015. A text book on Aquaculture Engineering, Narendra Publishing House.
3. Odd-Ivar Lekang (Eeds.) 2013. Aquaculture Engineering, John Wiley & and Sons, Ltd.
4. Odd-Ivar Lekang, 2020. Aquaculture Engineering, 3rd eEdition, Wiley-Blackwell.
5. Wheaton, F.W. 1993. Aquaculture Engineering, Krieger Pub Co.

Fisheries Economics 3 (2+1)

Objectives

- To teach economics theories for taking decisions by individual consumers, producers, and also farms.

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production contribution of fisheries sector to the economic development of the country.

Micro-Economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost.

Macro-Economics: Introduction to national income, accounting, measurement and determinants of national income, the contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalization and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practical

Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products. Calculation of price, income and cross elasticities. Production function – production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm/shrimp farm/seed production unit /fish processing plant/export unit.

Suggested 1readings

1. David M Kreps. 1990. A Course in Microeconomic Theory. Princeton University Press
2. Dewitt K.K. 2002. Modern Economic Theory. Sultan Chand and Co.
3. Geetika GP and Choudhury PR. 2011. Managerial Economics (2nd edn). New Delhi: Tata McGraw Hill Education Private Limited.
4. Jhingran ML. 2004. Micro Economic Theory. Vikash Publishing House Pvt. Ltd. New Delhi.
5. Haran J. 2012. Managerial Economics. Jaipur: Garima Publications.
6. Shrivastava OS. 2013. Modern Managerial Economics: Including Micro and Macroeconomics. New Delhi: Anmol Publications Pvt. Ltd.
7. Silberberg E and Suen W. 2001. The Structure of Economics – A Mathematical Analysis.

SEMESTER-VI

Fish Biotechnology and Bioinformatics 2 (1+1)

Objective

- To understand the basic principles of fish biotechnology and bioinformatics and its applications to fisheries

Theory

Introduction to Biotechnology –scope and importance in fisheries/ aquaculture. Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post-transcriptional modification and RNA processing. Gene regulation and

expression in prokaryotes and eukaryotes. DNA sequencing, Operons. Genetic engineering: Restriction enzymes, Gene isolation, Cloning vectors, Probes. Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism. Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting. Bioinformatics: Introduction to Bioinformatics. Biological Databases and tools: Introduction, Types of biological databases: Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

Practical

Study of structure of prokaryote and Eukaryote Cells. Isolation of DNA and RNA. PCR amplification. Gel Electrophoresis. Study on Model of protein Synthesis. Study of models of DNA Technology. Cell Culture. Isolation of Nucleic Acids. Restriction enzymes. ELISA. DNA sequence analysis and comparison. Study of data search engines. Study of different databases.

Suggested readings

1. Diwan AD. 2018. Biotechnology of penaeid shrimps. Narendra Publ.
2. Felix S and Ninawe AS. 2014. Aquaculture Biotechnology. Daya Publishing House.
3. Fletcher GL, Rise ML. 2012. Aquaculture Biotechnology. Wiley Blackwell.
4. Gautam NC. 2007. Comprehensive Biotechnology- Vol. 4 Aquaculture Biotechnology. Shree Publishers and Distributors
5. Green and Sambrook. 2012. Molecular cloning A laboratory manual. Fourth Edition. Cold Spring Harbor Laboratory Press Publ.
6. Greglutz C. 2001. Practical genetics for aquaculture. Wiley Blackwell Publ.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A.2012. Concepts of Genetics. Tenth Edition. Pearson Publ.
8. Lakra WS, Abidi, SAH, Mukherjee, SC, and Ayyappan S. 2014. Fisheries biotechnology.
9. Montet D and Ray RC. 2009. Aquaculture Microbiology and Biotechnology. Vol. 1. Science Publishers.
10. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
11. Pandian TJ, Strüssmann CA and Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ.
12. Primrose SB. 1989. Modern Biotechnology. Blackwell.
13. Reddy PVGK, Ayyappan S, Thampy DM and Krishna G. 2005. Fish Genetics and Biotechnology. ICAR.
14. Richard Reece, 2017. Analysis of genes and genomes.
15. Se-Kwon Kim, 2017. Springer handbook of marine biotechnology.
16. Sunita R. 2015. Fish Biotechnology. Random Publications.

Fish Immunology 2 (1+1)

Objectives

1. To impart knowledge on basic principles of fish and shellfish immunology
2. To understand the immune responses to infection by various fish pathogens and to offer scope for the development of disease protective/prevention measures against bacteria, fungi, viruses and parasites of fish

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell-mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types, epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells. Antigen-antibody reaction - Precipitation and agglutination reactions. Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non-specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease-producing organisms, portals of infection. Immunity to bacteria, fungi and parasites. Role of stress and host defence mechanism in disease development. Vaccines - types of vaccines – whole-cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants –types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practical

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination testimonies, diffusion, double immune-diffusion, radial immune-diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

Suggested readings

1. Abbas AK. 1991. Cellular and Molecular Immunology. Saunders Publisher, Philadelphia
2. Anderson DP. 2003. Textbook of Fish Immunology. Narendra Publishing House, Delhi.
3. Cooper EL. 1982. Immunology and Immunization of Fish. Pergamon Press, New York.
4. Cooper EL. 1982. General Immunology. Pergamon Press, Oxford.
5. Elgert KD. 2009. Immunology. John Wiley and Sons, New York.
6. Fikrig SM. 1982. Handbook of Immunology for Students and House Staff. Verlag Chemic International, Florida.
7. Paul WE. 2008. Fundamental Immunology. Wolters Kluwer, USA.
8. Richard C. 2015. Immunology A Short Course. Wiley Blackwell, UK.
9. Sharma DK. 2015. Immunology. New India Publishing Agency, New Delhi.

Therapeutics in Aquaculture 2 (1+1)

Objectives

1. To learn the principles and protocols of drugs in aquaculture
2. To impart knowledge of antibiotic used in aquaculture

Theory

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoans. Antibiotics used in aquaculture. Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders, and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anesthetics, flesh color enhancers, Chemicals of therapeutic value. Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices. List of the drugs used in aquaculture with therapeutics.

Practical

Regulations of drug use. Introduction to antimicrobials. Preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration (MIC). Five plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

Suggested readings

1. Bryan LE. 1989. Handbook of Experimental Pharmacology. Vol 91. Springer-Verlag, Berlin.
2. Brown KM. 2000. Applied Fish Pharmacology. Kluwer Academic Press, London.
3. Herwig N. 1979. Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases. Charles C Thomas, Springfield
4. Khory RN. 1999. Material Medica of India and their Therapeutics. Komal Prakashan, Delhi.
5. Lancaster R. 1980. Pharmacology in Clinical Practice. William Helnemann Medical Books Ltd., London
6. Moini J. 2009. Fundamental Pharmacology. Cengage Learning, New Delhi
7. Pandey G. 2017. Fish Pharmacology and Toxicology. DPH, New Delhi.

Coastal Zone Management 2 (1+1)

Objectives

1. To impart knowledge on the importance of coastal zones for human society
2. To teach the students on the different management strategies for the conservation of coastal zones

3. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Estuaries, Wet lands and Lagoons, Living resources – Non-living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application, and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities.

Practical

Field visit to different coastal environments to study erosion of beaches. Identification of ecologically sensitive areas and protection. Study of CRZ, ICZM along the coastal belt. Study on implementation and violation of CRZ. Study of application of remote sensing and GIS. Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation to combat disaster. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices. Project preparation of EIA.

Suggested readings

1. Cairns J Jr. 1994. Implementing Integrated Environmental Management Virginia Tech University.
2. Clark JR. 1992. Integrated Management of Coastal Zones. FAO Fisheries Technical Paper No. 327, Rome.
3. Coastal Area Management and Development 1982. U.N. Department of International Economic and Social Affairs, New York.
4. Ramkumar M, James A, Menier D, Kumarswamy K. 2018. Coastal Zone Management: Global Perspective, Regional Processes, Local Issue. Elsevier

Microbiology of Fish and Fisheries Products 2 (1+1)

Objectives

1. To teach nature and activity of microbes in fish and fishery products, microbiological spoilage and preservation.

2. To teach in detail about food-borne microorganisms of human health significance, food-borne diseases and their prevention.

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food. Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi-processed, and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products. Food-borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter* and *Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practical

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

Suggested readings

1. Anon. 2001. Food Borne Disease Handbook. 2nd edn. Vol. IV. Seafood and Environmental Toxins. Marcel Dekker.
2. Baveja, C. P. 2022. Text Book Microbiology. Arya Publishing Comp.
3. Chakraborthy P. 1995. A Text Book of Microbiology. New Central Book Agency.
4. Criusted J. 1986. Methods in Microbiology. Academic Press.
5. Doyle MP, Beuchat LR and Montville TJ. 1997. Food Microbiology - Fundamentals and Frontiers. American Society for Microbiology.
6. KR Aneja. 2008. Textbook of basic and applied microbiology, New Age International (P) Limited, Publishers (New Delhi).
7. Maheshwaii, D. K. 1999. A Text Book of Microbiology. S. Chand Publishing.
8. Michael J, Pelizar JR and Chan ECS. 1998. Microbiology. McGraw Hill.
9. Rita Narayanan 2013. Food Microbiology: basic and applied with laboratory exercises, New India Publishing Agency (New Delhi).
10. Roberts D, Hooper W, Greenwood M. 1995. Practical Food Microbiology: Methods for the Examination of Food for Micro-organisms of Public Health Significance, Public Health Laboratory Service (London).

11. Thomas J Montville, Karl R Matthews, and Kalmia E. Kniel. Food Microbiology: An Introduction, Third Edition. ASM Press.
12. William CF and Dennis CW. 2000. Food Microbiology. McGraw Hill

Refrigeration and Equipment Engineering 2 (1+1)

Objectives

1. To teach engineering aspects about refrigerators, freezers
2. To learn about heat load calculation and COP. To teach electrical aspects of fishing vessel

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work - A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. Refrigeration plant: Layout of refrigeration plant, Construction and insulating materials used for the cold storage construction, Frozen product storage, capacity of cold storage, usage of Anteroom. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. Compressors: Definition, Types of compressors, construction, working principle, advantages and disadvantages. Evaporator: Definition, Types of Evaporators, construction, working principle, advantages and disadvantages. Condenser: Definition, Types of Condensers, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice-plant: Ice plant planning, Brine tank construction, preparation of brine. Types of ice, storing of ice, Equipment used in ice plants. Freezers: Definition, Design, and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated Sea water (RSW), Chilled Sea water (CSW). Refrigerated transport. Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study, and use of Psychrometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipment. Theory of machines: Transmission of power, friction wheels, shaft, gears, belt, and Chain drive. Study of equipment used in fish processing with reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practical

Drawing of Refrigeration and Fish processing machineries, plant layout. Graphically represented symbols used in refrigeration. Handling and operation of compressors, condensers, evaporators expansion valves, low- and high-pressure switches. Study of auxiliary equipment: Receiver, oil

charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant, refrigeration plant, ice plant. Visit to fishing harbor or landing center to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

Suggested readings

1. Ayyappan VP. 2002. Elements of Electrical Technology. CIFNET. Cochin. 96p.
2. Joshy CD and Devadhason M. 2001. Basic Electronics and Fish Finding Equipment. CIFNET. Cochin: 42p.
3. Shawyer M and Medina Pizzali AF. The Use of Ice on Small Fishing Vessels. FAO. Rome: 102p.
4. Sternin UG, Nikonorou IV and Bumeister Yu K. 1976. Electrical Fishing. Keter. Publishing House Jerusalem Ltd. 258p.

Navigation and Seamanship 2 (1+1)

Objectives

1. To learn engineering aspects of fish acoustic equipment
2. To learn navigation and seamanship for fishing vessel safety

Theory

Principles of navigation –terms and definitions, finding positions and method of position fixing, magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay points, pelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and nonadjustable errors and principles and use. Hand lead line – construction and markings and method of taking soundings. Types of speed logs –patent log, impeller log. Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions. The IALA-buoy age systems, cardinal, and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations Indian coasts, Fog signals, types and methods. Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS. Principles of seamanship- Causes of fire at sea, fire prevention on board the vessel and method of firefighting at sea and recommended firefighting appliances. Lifesaving appliances – life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessels to face heavy weather. Temporary repairs for leaks constructions of the steering system and rigging emergency jury rudder. Types of anchors and their applications: selection of suitable anchorage, procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust, transverse thrust mooring and securing the vessel to the jetty, rigging fenders and gangways, and method of leaving vessels from the berth.

Practical

Anchoring, coming alongside the berth and leaving. Practicing the different types of knots and wire splices. Use of magnetic compass, GPS, Echo-sounder. CHART WORK - Finding positions by latitudes and longitudes by position lines, by cross-bearing, horizontal sextant, angles, vertical sextant angle and by running fix. Finding position by speed, distance and time. Finding set and drift of current and finding course. Steering course and finding position by counter acting the current observation of RADAR.

Suggested readings

1. CIFNET. 2004. Fishery Engineering: 212-238pp.
2. FAO. 1998. Fishing Operations. – Vessel Monitoring Systems, FAO Technical Guidelines for Responsible Fisheries No. 1, Suppl. 1, FAO Rome.
3. Joshy CD and Devadhason M. 2001. Basic Electronics and Fish Finding Equipment. CIFNET. Cochin: 31-42pp.
4. Larkin FJ. 1998. Basic Coastal Navigation, 2nd edn. Sheridan House Inc., New York: 273 p.
5. MacLennan DN and Simmonds EJ. 1992. Fisheries Acoustics, Fish and Fisheries Series 5, Chapman and Hall, London, 323 p.
6. Mitson RB. Fisheries SONAR. Fishing News Books Ltd. England: 274p.
7. Sreekrishnan Y and Shenoy Latha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research, New Delhi, 342 p.

Statistical Methods 3 (2+1)

Objectives

1. To learn basic statistical methods for research data analysis
2. To teach statistical problems for analysis

Theory

Definition of statistics, Concepts of population, sample, Census and sample surveys. Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives. Important measures of central tendency - arithmetic mean, median and mode. Relative merits and demerits of these measures. Important measures of dispersion - Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis. Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression. Length-weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practical

Construction of questionnaires and schedules. Diagrams and frequency graphs. Calculation of arithmetic mean, median, mode, range, mean deviation, variance, standard deviation. Exercises on probability, Binomial and Poisson distributions, Area of normal curve, confidence interval for population mean, Test of hypothesis based on normal, t, and chi-square. Computation of Simple correlation and regression. Fitting of length-weight relationship in fishes.

Suggested readings

1. Barbara Illowsky. et al. 2022. Introductory Statistics. Open Tax Publ.
2. Bruce, P., Bruce, A, and Gedeck. 2020. Practical Statistics for Data Scientists, Shroff/O'Reilly.
3. Das, N. G. 2017. Statistical Methods (vol. 1 and2), Tata McGraw Hill Education.
4. Gupta, C.B. 2009. An Introduction to Statistical Methods, 23rd edn, Vikas Publishing House.
5. Gupta, S. P. 2021. Statistical Methods, Sultan Chand and Sons.
6. Wasserman, L. 2004. All of Statistics: A Concise Course in Statistical Inference, Springer.

Fisheries Policy and Laws 1(1+0)

Objectives

1. To familiarize various fisheries policy and laws of our country
2. To gain in-depth knowledge on the fisheries and aquaculture policies for sustainable development

Theory

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of the department of fisheries, corporations and cooperatives. Different central and state-level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community-based resource management plans. Historical review of fisheries development and management in India and world. International agencies/organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries.

Suggested readings

1. Anon. 1998. Maritime Law of India in the International Context. Bhadarkar Publ.
2. Brahtz JFP. 1972. Coastal Zone Management. U.N. International Economic and Social Affairs, New York.
3. Burke William T. 1992. Fisheries regulations under extended jurisdiction and international law: Food and Agricultural Organization of the United Nations.
4. Churchill RR and Lowe AV. 1988. Law of the Sea. Manchester University Press.

5. Dixit 2013. Regulating oceanic fishing: international laws and treaties. Delhi Swastik Publications. 264pp. ISBN: 978-93-81991-04-6
6. Henkin L, Pugh RC and Smit H. 1993. International Law: Cases and Materials. West Publ. Co.
7. Holden M and Garrod D. 1996. The Common Fisheries Policy: Origin, Evaluation and Future. 2nd edn. Fishing News Books Ltd.
8. Kumar, U. Biodiversity Principles and Conservation, Narendra Publishing House Publishers and Distributors.
9. Pandey. 2014. Fisheries governance and legislation in India. Delhi Narendra Publishing House 2014: 182p. ISBN: 978-93-82471-85-1
10. Raval. 2013. Combating Marine Pollution: International Laws and Regulations. New Delhi Cyber Tech Publications 2013: 264p. ISBN: 978-93-5053-150-1
11. Sinha RK. (Ed.). 1996. Marine Resources and Applicable Laws (World Environmental Series – 009). Commonwealth Publ.
12. Verghese CP. 1989. Fishing Regulation in India's Territorial Waters. World Fishing.

Fisheries Co-operatives and Marketing **2 (1+1)**

Objective

- To familiarize students with basic concepts and principles of co-operative and marketing with reference to fisheries

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account. Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization in fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification-export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Practical

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government.

Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

Suggested readings

1. ICAR, 2003.Text Book of Agricultural Marketing and Cooperation, ICAR.
2. Krugman PR and Obstfeld M. 1991. International Economics: Theory and Policy. Harper Collins Publ.
3. Mahajan, K.A. 2003, Cooperative Marketing, Anmol Publications Pvt. Limited,
4. Ministry of Agriculture. Handbook of Fisheries Statistics. New Delhi.
5. Porter G. 1998. Fisheries Subsidies – Over fishing and Trade. Geneva.

SEMESTER-VII

ELECTIVE COURSES

Elective (major/minor) courses for VII Semester

S. No.	Course Title	Credit Hours
Major Courses (Students have the option to choose any Four Major Courses - 12 credits)		
1.	Open-water Aquaculture	3 (2+1)
2.	Smart Aquaculture Production Systems	3 (2+1)
3.	Fish and Shellfish Pathology	3 (2+1)
4.	Disease Diagnostic Techniques	3 (2+1)
5.	Sustainable Fisheries Management and Conservation	3 (2+1)
6.	Aquatic Pollution	3 (2+1)
7.	Fishery Oceanography	3 (2+1)
8.	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)
9.	Quality Assurance of Fish and Fishery Products	3 (2+1)
Minor Courses (Students have the option to choose any Four Minor Courses - 8 credits)		
1.	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)
2.	Aquatic Microbiology	2 (1+1)
3.	Climate Change and its Impact on Fisheries	2 (2+0)
4.	GIS and Remote Sensing in Fisheries	2 (1+1)
5.	Responsible and Sustainable Fishing Methods	2 (1+1)
6.	Principles and Techniques of Seafood Analysis	2 (1+1)
7.	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)
8.	Marketing Intelligence and Business Analysis	2 (1+1)
9.	ICT in Fisheries	2 (1+1)

A. Elective (Major) Courses

Open-Water Aquaculture 3 (2+1)

Objective

- To learn about the open water resources and their enhancement of aquaculture production

Theory

Overview of global scenario of aquaculture in open waters, open water resources in India, Present status, Utilization, Prospects of production augmentation, Utilization of open water bodies for aquaculture to enhance production. Salient features of open water limnology and their significance to fisheries development; management of small, medium and large water bodies; present status and future prospects in open water fish production. Recent advances in open water fisheries management; conservation measures in open water fisheries. Fish stocking in open water. Cage Culture: Role of cage in enhancement of fish production in reservoirs, estuaries, open sea and open water bodies; History of cage culture, advantages of cage culture; Cages for sea, estuaries, reservoirs, lakes and canals; Selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system; Different designs of open sea farming structures-construction of cages-bioengineering problems and solutions, Species selection for open water aquaculture, Rearing of fingerlings, advanced fingerlings and table size fish in open water bodies; Constraints in cage culture; Economics of cage culture; Integration of cage culture with other farming systems. Pen Culture: History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens; Suitable species for culture in pens; constraints in pen culture; economics of pen culture. Practices: Ranching in open waters, species quality and quantity, Natural feed enhancement, Supplementary feeding in cages and pens, Stock assessment, Harvesting and conflicts with irrigation, Drinking water and hydroelectric projects on open water farming. Environmental impact of Open water Aquaculture: Salinity intrusion, Effluent discharge, Eutrophication, Chemical residues including antibiotics and hormones, Destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.

Practical

Preparation of charts on the present situation of open water fisheries productivity. Different types of cage materials, fabrication of cages and pens and their installation. Determination of stocking density in cages and pens. Feeding in cages and pens. Stock assessment in cages and pens. Environmental impact of cages and pens. Case studies on cage and pen culture. Field visit to cage and pen culture site to acquaint with construction details and operation.

Suggested readings

1. Beveridge M. 2008. Cage Aquaculture. Oxford Publ.
2. Beveridge MCM. (Ed.). 2004. Cage Aquaculture, 3rd edn. Blackwell Publishing.
3. Burnell G and Allan G. 2009. New Technologies in Aquaculture. 1st Edition. Woodhead Publishing House.
4. Chiu Liao I and Kwei Lin C. 2000. Cage aquaculture in Asia: Proceedings of the First International Symposium on Cage Aquaculture in Asia, AFS and WAS Publ.

5. FAO. 2018. The State of World Fisheries and Aquaculture -Meeting the Sustainable development goals. Rome.
6. NFDB. 2018. Guidelines for Sea Cage Farming in India.
7. Syda Rao G, Imelda-Joseph, Philipose KK and Suresh Kumar M. 2013. Cage Aquaculture in India. CMFRI Publ.

Smart Aquaculture Production Systems 3 (2+1)

Objective

- To learn the advanced aquaculture production system research for different species globally

Theory

Introduction: An overview of global aquaculture production, demand- consumption scenario and emerging trends, Present status, Constraints and future prospects in India and the world, Aquaculture practices indifferent parts of the world, Enhancing carrying capacity in culture systems.

Biofloc technology: Principles of biofloc, Different carbon sources, Design of aeration system and biofloc reactor. Carrying capacity, C: N ratio, harvesting of biofloc, Biofloc quality and quantity, Biofloc as feed ingredient, Stocking of fish and shellfish species. Bioremediation in wastewater aquaculture. Minimal water exchange aquaculture systems: Principles of closed system farming, RAS, Components, design of mechanical and biological filters for the water reuse system, Sludge removal, disposal of wastes and control of pollution to the environment, Design of RAS, biofiltration and nitrifiers, Suitable cultivable species for indoor culture systems, polyhouses. Aquaponics: Principles, Components and design of different aquaponics systems, Components in aquaponics, ratio of fish and plants, Water quality and system maintenance, Resource utilization, Nutrient recycling and zero discharge of nutrients. Running water systems: Flow-through system, Raceways (IPR), IMTA, Partitioned Aquaculture Systems (PAS), Aquamimicry systems. Other farming methods: Cluster farming, Organic farming, Satellite farming, co-operative farming and conservation aquaculture, Network of production and marketing aspects, Economics of super intensive farming systems, Advantages and disadvantages.

Practical

Design, fabrication and performance evaluation of biofloc systems; Different equipment in closed grow-out system; Aerators, Biofilters, RAS, Raceways, IMTA, PAS and aquaponics systems; Plankton and microbial analysis of biofloc. Studies on different C: N ratio; Nutrient analysis in aquaponics; Visit to hatcheries with super-intensive models. Identification and understanding the network of the systems; Market analysis for the produces; Analysis of economic advantages, case studies.

Suggested Readings

1. Avnimelech Y. 2015. Biofloc Technology- a Practical Guidebook. 3rd edn. World Aquaculture Society
2. Chakrabarti NM. 2014. Biology, Culture and Production of Indian Major Carps.
3. Felix S. 2008. Biosecured Aquaculture- Principle and Prototype. Agrobios (India)

4. Soderberg RW. 1995. Flowing Water Fish Culture. Lewis Publishers.
5. Tidwell JH. (Ed.). 2012. Aquaculture Production Systems. Wiley-Blackwell.

Fish and Shellfish Pathology 3 (2+1)

Objective

- To understand the structural and functional changes in cells, tissues and organs in relation to the development of various finfish and shellfish diseases.

Theory

General pathology: Brief introduction to finfish and shellfish anatomy and histology; General pathology of finfish and shellfish Pathophysiology of fish: Pathophysiology of finfish and shellfish; Stress and stressors; General adaptation syndrome; Types of cellular adaptations; Hypertrophy, hyperplasia, Atrophy and metaplasia, Neoplasia. Inflammation and cellular pathology: Reversible cellular changes and accumulations; Fatty changes and pigments; Inflammation; Causes of inflammation; Cellular responses to inflammation; Mediators; various patterns of inflammation; The difference between acute and chronic inflammation; Tissue repair; Cell death; Necrosis, Apoptosis, Autophagy; Necroptosis; Their mechanisms and different morphological patterns. Clinical pathology: Normal constituents of blood; Alterations in the haematological parameters and enzymes with reference to different pathological conditions in finfish; Haematology of shrimp and molluscans; Clotting mechanisms; other host defence mechanisms.

Systemic pathology of finfish: Systemic pathology of finfish integumentary system, Respiratory system, Vascular system, Digestive system, Excretory system, Nervous system, Musculoskeletal and Endocrine system due to bacteria, Parasites and viruses. Systemic pathology of shellfish: Major pathological changes due to infectious diseases in the integumentary system, Lymphoid organ, Gill, Hepatopancreas, Gut and other organs of crustaceans; Major pathological changes due to diseases in molluscans.

Practical

Necropsy techniques. Collection and fixation of tissues. Complete histology and different staining techniques. Examination and interpretation of the pathological changes in fish tissues. Complete blood profile of finfish. Routes of blood collection from fish. Different staining techniques for blood cell visualization. Morphology of blood cells. Total leucocyte count. Differential leucocyte count.

Suggested Readings

1. Coleman WB. and Tsongalis GJ. 2009. Molecular Pathology. Elsevier Publisher, Boston.
2. Ellis AE. 1985. Fish and Shellfish Pathology. Academic Press, London.
3. Ferguson HW. 2006. Systematic Pathology of Fish. Scotain Press, London.
4. Killeen AA. 2001. Molecular Pathology Protocols. Humana, U.S.A
5. Lloyd RV. 2004. Endocrine pathology. Humana Press, Totowa.
6. Roberts RJ. 2012. Fish Pathology. Wiley-Blackwell, Chichester.
7. Salle AJ. 1961. Fundamental Principles of Pathology. MacGraw-Hill Co., New York.

Disease Diagnostic Techniques 3 (2+1)

Objective

- To comprehend theoretical and practical aspects of different disease diagnostic techniques used in aquaculture and to take appropriate decisions on fish health management and appropriate choice of treatment

Theory

Introduction to fish disease diagnosis: Introduction to disease diagnosis; different roles and levels of diagnosis in aquaculture; The evolution of diagnostic techniques in aquaculture; A brief introduction to diagnostic features of important diseases of finfish and shellfish. Microbiological techniques: Safety in microbiology laboratory; Bio-safety levels and risk groups; Techniques in sterilization; Preparation of microbiological media. Culture Microscopic techniques: Bright field, Darkfield, Phase contrast, Fluorescence and electron microscopy. Cell culture-based diagnostic methods: Introduction to cell culture techniques; Different cells used for virus isolation; CPE. Protein-based diagnostic methods: Antibody-based diagnostic methods (immunohistochemistry, ELISA, western blotting, lateral flow assay etc.), Hybridoma technology and monoclonal-antibody-based diagnosis Nucleic-acid based diagnostic methods: Nucleic acid amplification methods; Types of PCR: Reverse transcriptase-PCR, Real-time PCR and Other variants of PCR; In situ hybridization; Dot blot assay; LAMP etc.

Practical

Sample collection and preparation for microscopic, microbiological, virological and histopathological analysis. Culture of microorganisms using conventional methods. Antibiotic sensitivity testing. Serological techniques in disease diagnosis: SDS-PAGE, Western blotting, ELISA, etc. Cell culture techniques; Molecular techniques in disease diagnosis, Nucleic acid extraction, estimation and different PCR-based diagnosis. Familiarization of some of the commercially available diagnostic kits used in aquatic animal disease diagnosis.

Suggested Readings

1. Infectious Disease in Aquaculture. Woodhead Pub. Ltd., Philadelphia, 2012.
2. Lucky Z. 1977. Methods for the Diagnosis of Fish Diseases. Amerind Publishing Co Pvt Ltd, New Delhi.
3. Sindermann CJ. 1977. Disease Diagnosis and Control in North American Marine Aquaculture. Elsevier Scientific Publishing Company, Amsterdam.
4. Sugama K. 1998. Manual of Fish Diseases Diagnosis. Nippon veterinary and animal science University, Japan.
5. Walker P. 2005. DNA-based Molecular Diagnostic Techniques. Daya, Delhi.

Sustainable Fisheries Management and Conservation 3 (2+1)

Objectives

1. To understand the major sustainability issues of inland and marine fisheries resources of the world and India
2. To understand the ways and means of conservation of fisheries resource

Theory

Inland fisheries: Major inland fisheries resource of the World-India-Overview. State of the fisheries- Fishing gears-and crafts- Catch composition. Marine fisheries: Major marine fisheries resources of the world and India. Overview- State of the fisheries -Fishing gears - Catch composition-pelagic, Demersal, Oceanic, Deep-sea. Sustainability issues in fisheries: Ghost fishing-Overexploitation, Overcapacity, pollution, Habitat degradation/ biodiversity loss. Damming of rivers. Interlinking of rivers, Environmental flows; Fishing Conflicts-Exotics; Trans-boundary issues, IUU fishing, inter-linking of rivers-Climate change, By-catch and discards. Sustainable fishing: Components of sustainability, Indicators and goals of sustainability, Eco-friendly fishing, Ecosystem Based Fisheries Management-resilient fishery system. Principle of fisheries Management-Management approaches-By catch reduction- Rebuilding fishery, Rebuilding stock, Co-management - right based fishing input control (fishing efforts, mesh regulations, fishing ban, licensing, capital investments, etc.) - output control (catch quotas, minimum legal size, etc.). Fishery reserve-technical measures. Spawning aggregates; trade agreement- Market-based instruments; Access right - Catch sharing-balanced Fishing-Subsidy-certification and Traceability-Sustainable management approach in lake, Reservoir and beels. Functions and importance of Aquatic habitats: Mangrove, Corals, Seagrass beds, and dunes, Turtle nesting grounds, horseshoe crab habitat; Role and functions of aquatic habitat; Human activities and pollution sources; Effects of Conservation Practices on Aquatic Habitats and Fauna. Aquatic habitat conservation: Freshwater habitat and Marine water habitat; Erosion and sediment control-transplantation-stocking-population stabilization. Fish refugee- *ex-situ* conservation. Responsible fishing practices Precautionary management -Fisheries co-management: Right-based fishing - Catch sharing access right - Balanced fishing. Technical Guidelines of CCRF for responsible fishing; National and International treaties (National policy on marine fisheries-2017; National policy on inland fisheries 2019; MFRA's; UNCLOS; UNFSA; IOTC).

Practical

Capture fisheries observation at lakes, reservoirs, river stretches, and marine landing centers. Species landings analysis. Interaction with manager's Co-operative societies and stakeholders. Fleet capacity assessment. Visit to fishery reserves to understand management. Field survey and observation of fisheries issues. Development of management plan. Suggest management plan for aquatic habitat protection- permit application form. Valuation of ecosystems – awareness on fisheries resource conservation. Visit to reservoir and assess the threats and developing plan for stock rebuilding.

Suggested readings

1. Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman and Hall.
2. Chandra P. 2007. Fishery Conservation, Management and Development. SBS Publ. Dholakia AD.
3. FAO. Technical Papers on Freshwater Fisheries.
4. Hilborn, R. C. and C. J. Walters. 1992. Quantitative Fisheries Stock Assessment. Chapman and Hall. New York, New York.
5. Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.

6. Samuel CT. 1968. Marine Fisheries in India. Narendra Publ. House.
7. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House
8. McClanahan. 2000. Coral reefs of the Indian ocean: their ecology and conservation. Oxford University Press. 525p.
9. Nath S. (Ed.). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation. Vol. VII. Narendra Publ. House.
10. Ramachandra, 2005. Aquatic ecosystems: conservation, restoration and management. Description: New Delhi: Capital Publishing Company. 348p.
11. Young TP. 2000. Restoration Ecology and Conservation Biology. Biological Conservation.

Aquatic Pollution 3(2+1)

Objectives

1. To impart knowledge on different aspects of aquatic pollution
2. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment. Classification of pollution; Physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes; composition and pollution effects, sewage treatment and its reuse. Agricultural wastes; organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand (BOD, COD), Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution - Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Solid waste management.

Practical

Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphone, phosphates, ammonia, nitrates, nitrites, heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Bacteriological tests of waste water: Coliform tests, IMVIC test, standard plate

count. Methods of enumerating bacterial biomass in waters and waste waters. Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.

Suggested readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edn. American Public Health Association, Washington, D.C.
2. Baird DJ, Beveridge MCM, Kelly LA and Muir JF. 1996. Aquaculture and Water Resources Management. Blackwell Science Ltd., Oxford.
3. Clark RB. 2001. Marine Pollution. Oxford University Press.
4. Czernuszenko W and Rowinski P. 2005. Water Quality Hazards and Dispersion of Pollutants. Springer Science and Business Media.
5. Gray NF. 2004. Biology of Wastewater Treatment. Oxford University Press, London.
6. Mason C. 2002. Biology of Freshwater Pollution. 4th edn, Benjamin Cummings, 400 pp.

Fishery Oceanography 3 (2+1)

Objectives

1. To educate the students on the oceanographic concepts related to fisheries and impart skill to operate oceanographic equipment
2. To understand the role of different oceanographic parameters on fisheries production

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification. Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El Nino and Southern Oscillation. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO_2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution. Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal.

Practical

Field visits and operation of oceanographic instruments - Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water. Use of tide tables. Fisheries forecasting systems. Oceanographic equipment and fish-finding devices.

Suggested Readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. Verlag Chemie, Weinheim.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
3. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
4. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
5. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
6. Pond S and Pickard GL. 2013. Introductory Dynamical Oceanography. Elsevier.
7. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.
8. Tomczak M and Godfrey JS. 2013. Regional Oceanography: An Introduction. Elsevier.

Analytical Techniques in Aquatic Environmental Studies 3 (2+1)

Objective

- To teach the student advance analytical techniques in aquatic environment studies

Theory

Qualitative and quantitative analytical techniques including Gravimetric and volumetric analyses used in environmental science, Sampling techniques and procedures, Factors affecting the choice of analytical techniques, Interferences and their minimization, Laboratory safety measures. Photometric techniques: Theory, instrumentation and application of spectrophotometry and spectroscopy, AAS, ICP-MS, Biosensor, Microscopic Techniques etc. Theory and applications of electrophoresis, Principles and uses of ultra-centrifugation, Tracer Techniques, Isotopes in environmental analysis. Separation techniques: Chromatography – theory, instrumentation and applications of thin layer, paper, ion-exchange, size exclusion, high performance liquid and gas chromatography. Methods of preparing biological samples for chromatographic analysis GC-MS Unit. Bioanalysis techniques: Immunoassay – Principle, methods and applications and Biosensors – components, characteristics, applications, impacts and challenges. Nanotechnology: Preparation of nanoparticles, characterization and applications.

Practical

Eutrophication studies in natural waters - tanks and ponds Estimation of bio-indicator organisms in polluted waters. Bioremediation experiments using different bio-agents. Use of UV-visible Spectrophotometer for phosphate, nitrate other ions. AAS for analysis of heavy metals. Use of

HPLC and GC-MS for analysis of pesticide and other volatile and semi volatile organic substances.

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edn. American Public Health Association, Washington, D.C.
2. Cheremisinoff NP. 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann, Woburn.
3. Cairns JE. 2017. Biological Monitoring in Water Pollution. Elsevier.
4. Sakhare VB. (Ed.). 2007. Advances in Aquatic Ecology. Vol. 1. Daya Publishing House, New Delhi.

Quality Assurance of Fish and Fishery Products 3 (2+1)

Objective

- To familiarize students with different aspects of quality management systems and evaluation techniques for seafood

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post-harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance program for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze-dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non-mandatory standards. Role of export inspection council and export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India. Certification system for fish and fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish and fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality. Prerequisites to HACCP. Labelling for product traceability and Labelling requirements - National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products. Assessment of food safety program, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods. FSSAI, FDA, ISO. Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practical

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled

fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

Suggested Readings

1. Alasalvar C, Miyashita K, Shahidi F, and Wanasundara U. 2011. Handbook of Seafood Quality, Safety and Health Applications. Wiley-Blackwell (Oxford).
2. Huss. 2007. Assessment and Management of Seafood Safety and Quality. Daya Publishing House (Delhi)
3. Kanduri L and Eckhartt RA. 2002. Food Safety in Shrimp Processing. Fishing News Books.
4. Kreuzer R. 1971. Fish Inspection and Quality Control. Fishing News Books.
5. Shukla RK. 2006. Total Quality Management Practicing Manager. New Royal Book.

B. Elective (Minor) Courses

Coldwater Aquaculture and Recreational Fisheries 2 (1+1)

Objectives

1. To learn about the breeding and culture of different cold-water fishes and their importance as sport fisheries or recreation fisheries
2. Eco-tourism and recreational aquaculture

Theory

Introduction: Status of coldwater fisheries in World with special reference to India, Biology, breeding and culture of trouts (*Oncorhynchus mykiss, Salmo trutta fario, Schizothoraichthys esocinus, S. longipinnis, S. niger, Schizothorax richadsonii*), mahseer *(Tor putitora, Tor tor, Tor khudree)*, common carp *(Cypinus carpio cummuinis, Cyprinus carpio specularis)*. Specific environmental parameters pertaining to cold water fish culture and metabolic interaction, Feeds suitable for cold water aquaculture. Culture of cold-water fishes: Construction and management of cold-water fish farms, Effect of exotic fish introduction on indigenous fish fauna, Polyculture of exotic carp in mid hill region based on three Chinese carps, post-harvest and harvest issues in trout with regards to cold water species, Special factors for consideration in cold water fish seed production and nursery rearing. Introduction to sport fisheries: Sports fishes and their life history, Equipment for sports fishing, fishing methods, area suitable for sports fishing, etc. Management and conservation of sports fisheries through aquaculture, Sport fisheries and tourism, recreational aquaculture. Issues and Desired Interventions: Potential and Innovative Strategies for the Development of coldwater Aquaculture in India- problems encountered in fisheries development of rivers supporting cold water fisheries.

Practical

Identification of coldwater fish species. Primary and secondary sexual characters in cold water fishes. Different breeding methods for cold water fishes. Identification of larval stages of trout and mahseer. Preparation of hatchery layout for coldwater fishes. Studies on different types of sports fishing equipment. Visit to coldwater fish hatcheries and farms.

Suggested readings

1. Boghen, A.D. 1989. Cold-water aquaculture in Atlantic Canada. Institut Canadien de recherche sur le development regional, Atlantic Coast, Canada
2. ICAR. 2006. Handbook of Fisheries and Aquaculture.
3. Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.
4. Mahanta, P.C. and Sarma, D. 2010. Coldwater Fisheries Management. ICAR
5. Singh, H.R. and Lakra, W.S. 2008. Coldwater Aquaculture and Fisheries. Narendra Publishing House.
6. Singh AK, Sarma D, Akhtar, MS and Baruah D. 2017. Souvenir – National seminar on strategies, innovations and sustainable management for enhancing cold water fisheries and aquaculture. ICAR-DCFR, Bhimtal.

Aquatic Microbiology 2 (1+1)

Objective

- To impart knowledge on aquatic microorganisms with reference to their role in the aquatic environment and bioprospecting.

Theory

Distribution and classification: Microbial community in freshwater; Estuarine and marine environment (types and abundance); Factors affecting microbial growth and abundance. Microbial interaction: Microbial degradation of persistent organic pollutants (POPs); Microorganisms and public health: Water-borne pathogens of public health importance - Protozoans, bacteria, enteroviruses; Microbial toxins; Algal toxins; Disinfection methods; Microbial standards for different water uses. Principles and applications of bioprocesses: Bioremediation, Biofertilization, Biofilms, Biofloc, Probiotics, Bio-leaching, Bio-corrosion, Bio-fouling; Microorganisms as Bioindicators and Biosensors. Methods of assessing microbial biomass production; Bioprospecting: Current practices in bioprospecting and biopiracy; Microbial metabolites and its industrial application.

Practical

Isolation, identification and enumeration of algae and bacteria from polluted aquatic habitats. Maintenance of algal and bacterial cultures. Microbial sensitivity testing. Bio-activity testing. Disinfection methods.

Suggested Readings

1. Dhevendaran K. 2008. Aquatic Microbiology, Daya Publishing House, New Delhi.
2. Droop MR and Jannasch HW. 2012. Advances in Aquatic Microbiology. Volume One. Academic Press, 388 pp.
3. Frobisher M, Hinsdill RD, Crabtree KT and Goodheart CR. 1974. Fundamentals of Microbiology. WB Saunders Company, Philadelphia.
4. Maier RM, Pepper IL and Gerba CP. 2009. Environmental Microbiology. 2nd edn, Academic Press, 624 pp.

5. Rheinheimer G. 1992. Aquatic Microbiology. John Wiley and Sons.
6. Sigee, D.C. 2005. Freshwater microbiology. Wiley Publisher, 517pp.
7. Vernam AH and Evans M. 2000. Environmental Microbiology. Blackwell Publishing, U. K

Climate Change and its Impact on Fisheries 2 (2+0)

Objectives

1. To understand global warming, its impact on the aquatic environment and fisheries
2. To know about the different legislation across the country to combat climate change

Theory

Weather and climate, Greenhouse effect, Radiative balance, Climatic migration, Carbon Sequestration and trading, Projected trends of climate change and disasters. Climate change, its impacts, Aquatic ecosystem, Capture and culture fisheries, Carbon footprint in fisheries and aquaculture. Oceanographic factors in fisheries: Effects of physio-chemical and biological oceanographic factors on adaptation; Behaviour, abundance and distribution of aquatic organisms; Primary and secondary productivity in ocean under changing climate. Ocean acidification, Global Ocean circulation, Upwelling and circulation patterns, El Nino and Southern Oscillation, IPCC and its reports, UNFCCC, Kyoto Protocol, Politics of climate change. Forecasting systems: Fisheries forecasts – Interpretation and use of ocean thermal structure; Fisheries forecasting system in India and other countries: Application of Remote sensing and GIS in fisheries; Application of echo-sounders and SONAR; Potential fishing zones. Factors affecting marine fisheries. Adaptation and mitigation measures for Climate change; Vulnerability assessment; Climate-resilient aquaculture; Climate-smart villages.

Suggested Readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. Verlag Chemie, Weinheim.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
3. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
4. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
5. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
6. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.
7. Hulme M. 2009. Why we disagree about climate change: Understanding controversy, inaction and opportunity. Cambridge University Press.
8. Murphy RP and Boomer D. 2008. An Appeal to Reason: A Cool Look at Global Warming, By Nigel Lawson-super-1. Economic Affairs, 28(4), pp.80-81.
9. Schmutter K, Nash M and Dovey L. 2017. Ocean acidification: assessing the vulnerability of socioeconomic systems in Small Island Developing States. Regional environmental change, 17(4), pp.973-987

GIS and Remote Sensing in Fisheries 2 (1+1)

Objective

- To learn to use GIS and Remote sensing to foster the sustainable use of natural fisheries resource.

Theory

Aerial Photography: Basics of photography- terminologies- Photogrammetry - Stereoscopy - Principal points - Parallax and its measurement, Colours - Composite colour images. Remote Sensing - Electromagnetic Spectrum - Radiation laws - Interaction with atmosphere and surfaces, Spectral reflectance of earth materials and vegetation, Satellite Remote Sensing - Resolution - Scanning - Sensors, Land Observation Satellites - Visual image interpretation. Image and Data: Digital image processing, Image rectification and Image enhancement - Filtering - Band rationing, Image classification - Supervised andunsupervised classification, Remote sensing application in soil andwater conservation. GIS - Types, raster, vector, Database management systems, Data types, Spatial - non-spatial, Spatial data models, Spatial referencing, Map projections, Data input, Editing, Encoding, Raster data analysis, Vector data analysis. Satellite Application: NOAA and IRS-Satellites for Ocean and Fisheries studies, Digital image processing and interpretation, Application of remote sensing and GIS to fisheries and aquaculture planning and development. PFZ- Basics and application- Validation of PFZ data- INCOIS- Data Dissemination. Fishermen knowledge in PFZ.

Practical

Study of satellite information, interpretation of satellite pictures for resource management. Case studies on remote sensing and GIS applications. Development of GIS with local parameters related to fisheries. INCOIS data processing and interpretation. Collection and Validation of INCOIS and PFZ data. INCOIS data dissemination methods among coastal fishermen. Survey of effectiveness and usefulness of PFZ data.

Suggested Readings

1. Bhatia B. 2008. Remote Sensing and GIS, Oxford University Press, New Delhi.
2. FAO Technical Manuals on Remote Sensing and GIS in Fisheries and Aquaculture.
3. Josef G. 2005. Fundamentals of Remote Sensing, Universities Press (P) Limited, Hyderabad.
4. Kumar S. 2005. Basics of Remote Sensing and GIS, Firewell Medi, Laxmi Publications, New Delhi.

Responsible and Sustainable Fishing Methods 2 (1+1)

Objectives

1. To teach various responsible fishing techniques for conservation of biodiversity.
2. To learn various fishing methods and gears for the sustainable exploitation of aquatic resources

Theory

CCRF: Scope and objectives of FAO Code of conduct for Responsible Fisheries, Articles of CCRF – Description of the code, Analysis of marine catch data (present and past); analysis

of CCRF concept. Definition of sustainability, Rules and regulations for sustainable fishing, Properties of a sustainable fishery, Present scenario and problems of sustainable fishing, Trends in global and Indian fishery, Environmental defects. By-catch: Elaboration of Article 8 – Fishing operations; By-catch and discards – Definitions, By-catch estimation methods, by-catch reduction devices, turtle excluder devices, Finfish and shrimp excluder devices. Selective fishing gear and practices: Selectivity of trawls, gill nets and lines – Environmentally friendly fishing methods and fishing gears – Energy conservation and resource enhancement. Fish Aggregation Devices (FADs and Artificial reefs): Objectives, Types of FADs and artificial reefs; Design and construction of FADs and artificial reefs; Energy optimization in fisheries – Methods of energy conservation in fish harvesting. Remote Sensing and PFZ: Application of Remote sensing, PFZ and GIS in fisheries. IUU - Illegal, Unregulated and Unreported fishing methods; Destructive and prohibited fishing systems and practices. Effect of fishing on non-target species. Impacts of unsustainable fishing: Habitat degradation due to bottom trawling, purse seining, Habitat modification, changing the ecosystem balance, Climate change, Ocean pollution, Disease and toxin. Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Conservation methods issues and implications for biodiversity. Remediation for sustainable fishery, Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Awareness campaigns, Sustainable fishing gears and devices, designing of eco-friendly long line, Eco-friendly gillnet, Eco-friendly trawl net, Techniques reducing the risk of unsustainability, Eco-friendly fishing methods and gears.

Practical

Study of design and operation of BRDs and TEDs. Preparation of document listing and prohibited fishing practices. Compilation of package of practices for energy conservation. Designing of eco-friendly fishing devices, square mesh cod end, traps with escape vents, designing of longline with circular hooks. Interpretation of SST and Ocean colour charts. Study of Potential Fishing Zone (PFZ) maps. Problems on fishing gear selectivity. Studies on impact of various fishing gears on the environment and biodiversity.

Suggested Readings

1. CIFNET module III and IV. Code of Conduct for Responsible Fisheries. 61-69pp.
2. FAO. 1995. Code of Conduct for Responsible Fisheries, FAO, Rome, 41p.
3. FAO. 1996. Fishing Operations, FAO Training Guidelines for responsible fisheries No.1, FAO, Rome 26p.
4. FAO. 2003. Fisheries Management. 2. The ecosystem approach to fisheries, FAO
5. Maheswari K. 2011. Sustaining Marine Fisheries. Sonali publication, New Delhi.
6. Michel Kaiser and Groot. Effect of Fishing on Non-target species and Habitats Blackwell publishing.
7. Raval NB. 2013. Combating Marine Pollution. Cyber tech publication, New Delhi.
8. Sinha PC. 2007. Fishing Conservation Management and Development. SBS Publishers and distributers Pvt. Ltd, New Delhi.
9. Technical Guidelines for Responsible Fisheries – No.4, Suppl.2, FAO Rome

Principles and Techniques of Seafood Analysis 2 (1+1)

Objective

- To provide knowledge on various instrumental techniques in seafood analysis

Theory

Separation of molecules: General principles of separation of micro and macro-molecules, Selection of appropriate tools for analysis of fish samples, Outlines of common techniques involved in biochemical analysis. Filtration and centrifugation techniques: Different types of filtrations, Types of filters and means of using them; Types of centrifugations (preparative and analytical), concept of Svedberg unit, Selecting appropriate rotor, Relative centrifugal force. Viscoelastic properties, Rheology, Tribology, TPA; IR and FTIR spectrophotometry, Spectro-fluorimetry, ICP, Atomic absorption mass spectrometry, Tandem MS/MS. Microscopy: Fluorescence microscopy, SEM, TEM, XRD. Electrophoresis: General principles, types (native, denatured PAGE, 2D). Chromatographic techniques; General principle, Types of chromatography: adsorption, partition, ion-exchange, molecular sieve, affinity, liquid and gas chromatography (GC), thin layer chromatography, HPLC, GCMS, LCMSMS.

Practical

Characterization of proteins based on solubility: sarcoplasmic, myofibrillar, and stroma; Estimation of proteins - Biuret techniques, Lowry techniques, Dye binding technique and electrophoretic techniques. Amino acid analysis by HPLC. Fatty acid analysis by GC MS, Minerals and heavy metals by Atomic Absorption spectroscopy. Texture analysis by TPA. HPLC- determination of histamine. Demonstration of GC-MS-MS.

Suggested Readings

1. Ewing GW. 1997. Analytical Instrumentation Handbook. Marcel Dekker.
2. Lakshmanan. 2010. Modern Analytical Techniques Central Institute of Fisheries Technology (Cochin).
3. Leo ML, Nollet and Fidel Toldra. 2010. Handbook of Seafood and Seafood Products Analysis CRC Press Inc. (Florida)
4. Otles S. 2016. Handbook of Food Analysis Instruments. CRC Press.
5. Pare JRJ and Belanger JMR. 1997. Instrumental Methods in Food Analysis. Elsevier.
6. Robyt JF and White BJ. 1990. Biochemical Techniques - Theory and Practice. Waveland Press.
7. Wilson K and Walker J. 2000. Practical Biochemistry - Principles and Techniques. Cambridge University Press.
8. Wilson RH. 1994. Spectroscopic Techniques for Food Analysis. VCH Publ.

Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products 2 (1+1)

Objective

- To create basic understanding about Trade Regulations, Certification and documentation in export of fish and fishery products.

Theory

Trade policy and Legislation on labelling and other standards: Foreign Trade Policy of Fish and Fishery Products in Indian context and world context, labelling requirements of Fish and Fishery products stipulated by National and International Organizations. Regulations: Export documentation- certificates of origin. Other certificates for Shipment of specific goods, Export licenses; Import regulations, SPS-TBT agreement. Export Certification systems: Consignment-wise, in process Quality, Self-Certification, Food safety management system, Pre-shipment inspection, Voluntary food certification scheme, Certificate for export (CFE), Health certificate. Other certification, Traceability issues for farm reared and wild aquatic products; Dealing with returned consignments; foreign trade regulations in India.

Practical

Documentation protocol for approval of fishing vessel, processing unit and technologist in processing plants. Labelling codes for Traceability of products in Export trade. Preparation of BOL and LC. Preparation of documents for seafood export to different destinations. Study of documents on customs and port procedures for seafood export and import.

Suggested Readings

1. Batra GS and Kaur Narinder. 1995. Foreign Trade and Export Policy, Anmol Publications Pvt Ltd.
2. Cherian Jacob. 1997. Export Marketing, Himalaya Publishing House.
3. EIC, Export of Fresh, Frozen and Processed Fish and Fishery Products A Guide for Exporters, Export Inspection Council
4. Mittal AC. 1991. Export Management in India. Om Sons. Publications.
5. Rathore Kumkum. 1994. Export Marketing, Arihant Publishing House.

Marketing Intelligence and Business Analysis 2 (1+1)

Objective

- To give an idea about the marketing intelligence and business analysis applied in the fisheries sector

Theory

Research methodology: The role of marketing intelligence in the firm, The process of marketing research, The difference between exploratory and confirmatory research, Secondary and primary data, Qualitative and quantitative research methodologies, Sampling theory. Requirements in business analysis: Management, Communication, Tracing, Configuration and change management, quality assurance, Development, Elicitation including stakeholders and/or product requirements development, Specification. Business analytics: Business Analysis, Internal analysis, External analysis, Business need definition, Gap analysis, Solution proposal (including feasibility analysis), Solution delivery or maintenance program/project initiation-Business process definition, Business goals, Business needs, Business requirements, Limitations and assumptions. Modelling and forecasting: Solution modelling, validation and verification,

Solution evaluation and optimization, Assessing the solution options (proposals), Evaluating performance of the solution, Solution/business process optimization, Model Volatility with ARCH and GARCH for Time Series Forecasting. Marketing research: Definitions of the various methodological concepts -Various steps involved in designing a research plan, Data collection methods; Characteristics, Structure, Sources, Value, and use of Big Data. The relationship between digital analytics and inbound marketing strategies, Consumer information and measurement services, Rules for designing a questionnaire. Data analysis in marketing research: Data sources for assessing consumer preferences, firm performance, and market condition and competition-analyze enterprise data, especially for purposes of segmentation, targeting, positioning, and evaluating consumer value- process of organizing, writing, framing, and refining analytics reports- delivering effective presentations, and aligning analytic results with stakeholder needs and preferences.

Practical

Marketing Research – ethics, standards and issues. Utilization of Secondary Data Resources for Customer Segmentation Pricing and Elasticity. Linear Regression, Basics; Using Linear Regression to Forecast. Conjoint Analysis; Digital Marketing Metrics Customer Lifetime Value; Cluster Analysis. Finding and interpreting secondary data. Suggesting a methodology for fisheries marketing research. Tools and concepts of data visualization.

Suggested Readings

1. Carlson C.C., Wilmot, W.W. Innovation: The Five Disciplines for Creating What Customers Want, New York: Crown Business, 2006, ISBN: 0307336697 Edition, ISBN 13: 978-0-13-608543-0
2. eNAM – National Agricultural Market https://enam.gov.in
3. Harrington H. James. 1991. Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness. Inspires Innovation, HarperCollins, 2009, ISBN 978-0061766084
4. Malhotra, Naresh. Marketing Research: An Applied Orientation, Sixth
5. MPEDA – Marine Products Export Development Agency – mpeda.gov.in
6. NFDB- National Fisheries Development Board – nfdb.gov.in.
7. Pearson Prentice Hall Analyzing the Target Market, Part 1: Chapter 3, Marketing Research, Harvard Business Publishing BEP 117, length 18 pages.

ICT for Development 2 (1+1)

Objective

- To orient students on advances in ICT initiatives, knowledge management process smart/ disruptive technologies and data analytics

Theory

ICTs – meaning, concepts, roles and initiatives, basics of ICTs, Global and National status, Types and functions of ICTs, Meaning of e-Governance, e-learning, m-Learning, Advantages and

Limitations of ICTs. Knowledge management: Meaning, Approaches and Tools, Role of ICTs in Agricultural Knowledge Management, e-Extension, overview on Global and national e-Extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGOs in India**.** ICT applications: Knowledge centres (tele centres), CSC, Digital kiosks, Web portals, Community radio, Internet radio, Kisan call centres, Mobile based applications, INCOIS-PFZ advisories; Self-learning CDs on Package of practices, Augmented Learning, Virtual Learning, social media, Market Intelligence and Information Systems-e-NAM, Agmarknet, etc. Expert System/ Decision Support System/ Management Information Systems, Farm Health Management and Intelligence System for Plant /Animal/ Soil Health, Fishery, Water, Weather, etc., National e-Governance Plan in Agriculture (NeGP-A). Networks and policies: Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Coursera, EduEx, etc.); Digital networks among extension personnel, Farmer Producers Organisations (FPOs) / SHGs/ Farmers Groups, Video conference, Live streaming and Webinars, types and functions of social media applications, Guidelines for preparing social media content, Engaging audience, Data-analytics and Info graphics. Smart technologies for extension: Open technology computing facilities, System for data analytics/ mining/ modelling/ Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU). Disruptive technologies Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), Blockchain technology, Social media and Big Data analytics for extension.

Practical

Content and client engagement analysis. Case studies and exercises on ICT-based interventions in fisheries and agriculture. Designing extension content for ICTs; Creating and designing web portals, blogs, social media pages. Development and use of online and offline e-learning modules in fisheries. Live streaming extension programs and organizing webinars. Visit to KCC; Exercises on developing mobile-based applications. Developing social media pages for disseminating fisheries-related information. Writing for digital media. Developing video content related to fisheries. Conducting exercise on remote sensing and GIS.

Suggested Readings

1. August E Grant and Jennifer H. Meadows (Ed.). 2012. Communication Technology Update and Fundamentals, Focal Press, USA.
2. Batcheloret et al. 2003. ICT for Development: Contributing to the Millennium Development Goals: Lessons Learned from Seventeen ICT Development Projects, World Bank.
3. Donner J and Parikh T. (eds). 2013. ICTD2013. Proceedings of the Sixth International Conference on Information and Communication Technologies and Development held in Cape Town, South Africa.
4. Elder L, Emdon H, Fuchs R and Petrazzini B. (eds). 2013. Connecting ICTs to Development, Anthem Press, London.
5. ICTs for Development (http://ict4dblog.wordpress.com/).

SEMESTER-VIII

Student READY (Students Entrepreneurship Awareness Development Yojana) Program containing the following four components:

i) Rural Fisheries Work Experience (RFWE)

ii) Experiential Learning Program (ELP)

iii) In Plant Training/ Industrial Attachment

iv) Students Projects

v) Seminar

1. Rural Fisheries Work Experience (RFWE) Program**:** Students will be attached in the fisher's villages for a minimum of 8 weeks to accustom with the rural fisheries activities like fish farming, fish breeding, hatchery operation, fishing in the river and seas, preparation of fishing crafts etc. It will be conducted with the help of the fisheries extension officers of the state Govt. of the respective states and teachers appointed by the Dean of the respective college. A total of 6 credits are allotted for the program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college/university and fisheries officers engaged for the program.

2. Experiential Learning Program (ELP): Students will be completing an ELP at least in two areas which should be decided by each university/college. Areas of specialization for Experiential Learning Program are (i) Ornamental fish culture, (ii) Seed Production, (iii) Trade and export management, (iv) Aqua-clinic, (v) Post Harvest technology, (vi) Aqua- farming. A total of 6 credits are allotted for Experiential Learning Program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college.

3. In-Plant training/Industrial Attachment**:** Students will be attached in the fish farms/ hatcheries/ feed plant/ fish processing plant etc. in the Govt./ Private/ NGO organizations for a minimum of 8 weeks. The company/farms/organization will be issued a courses completion certificate of each student after completion of the course. A total of 5 credits are allotted for the program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college/university.

4. Project work: Student will be selected relevant or interested area of specialization such as Ornamental Fish Production, Fish Genetics and Breeding, Fish Nutrition, Fish Pathology, Fish Health Diagnosis, Fish Pharmacology, Fish Toxicology, Fish Immunology, Fish Stock Assessment, Aquatic Pollution, Fish Value Addition, Fish Processing Waste Management, Quality Control and Quality Assurance of Fishery Products, Fish Products and By-products etc. He/she will prepare a research project plan and it will be presented in front of the committee appointed by the Dean of the respective college/university. Also, for each student, one advisor will be provided, who will guide the student in the completion of the proposed research plan. A total of 2 credits are allotted for project work and 1 credit for seminar (completed project work presentation). The evaluation for the same will be conducted by the committee appointed by the Dean of the respective college/university with the advisor of the student.

5. Seminar:

SKILL ENHANCEMENT COURSES

- Students will be offered Skill Enhancement Course (SEC) consisting of courses from different areas to provide intensive Hands-on-training on campus or off Campus. Students may choose SIX Skill Enhancement Courses from the basket of SEC in 1st to 4th Semesters.
- University may introduce more Skill Enhancement Courses based on the available facilities and prospect of local employment and entrepreneurship development as well as expertise/ resources available
- Students may opt UGC recommended short skill enhancement courses also (a list of skill development training areas as given in the main report).

Sl. No.	Course Title	Credit Hours
Aquaculture		
SEC-I	Fish/Shellfish Breeding and Hatchery Operation	2 (0+2)
SEC-II	Fish/Shellfish Seed Rearing	2 (0+2)
SEC-III	Fish/Shellfish Grow-out Production Management	2 (0+2)
SEC-IV	Breeding and Culture of Ornamental Fish	2 (0+2)
SEC-V	Integrated Fish Farming	2 (0+2)
SEC-VI	Non-conventional/Diversified Farming Practices (Pearl Farming/ Seaweed Farming/ Aquaponics/Microalgae Production, etc.)	2 (0+2)
SEC-VIII	Fish Feed Production and Marketing	2 (0+2)
SEC-XIII	Aquarium Making, Decoration and Management	2 (0+2)
Aquatic Environment Management		
SEC-VII	Analytical Techniques (Testing of Water, Soil, Feed etc.)	2 (0+2)
Aquatic Animal Health Management		
SEC-IX	Laboratory Techniques for Fish Pathogen Detection	2 (0+2)
Fish Processing Technology		
SEC-X	Preparation and Marketing of Value-Added Products	2 (0+2)
SEC-XII	Preparation of Fish By-Products and Waste Utilization	2 (0+2)
SEC-XVI	Fish Handling, Transportation and Preservation	2 (0+2)
SEC-XVII	Bio-chemical Analysis of Fish and fisheries products	2 (0+2)
Fishing Technology and Engineering		
SEC-XIV	Net Making and Mending	2 (0+2)
Fishery Extension, Economics and Statistics		
SEC-XV	Start-up and Incubation in Fisheries	2 (0+2)
SEC-XVIII	Data Analysis and Computation	2 (0+2)
SEC-XIX	Fish Market Survey and Value Chain Analysis	2 (0+2)
Others		
SEC-XX	Any other relevant to the region, which may be decided by the College	2 (0+2)

ONLINE COURSES

- SAUs/CAUs will be free to include more online courses of 10 crdits (as per UGC guidelines for online courses) as a partial requirement for the B. F. Sc programme. Student will take in online mode, with approval from Dean of the SAU/CAU/College.

Indicative List of Online Courses on SWAYAM/MOOCs/Others

	Course Title	Duration	Credits
1.	Climate-smart fisheries and aquaculture (FAO)	16 weeks	1
2.	Food loss and waste in fish value chain (FAO)	12 weeks	1
3.	Biostatistics (SWAYAM)	14 weeks	4
4.	Econometric Analysis (SWAYAM)	15 weeks	4
5.	Fisheries Ecosystem Approach to Fisheries (FAO)	12 weeks	1
6.	Sustainable Management of Biodiversity (SWAYAM)	12 weeks	4
7.	Indian Agriculture Development (SWAYAM)	20 weeks	4
8.	Environment Sustainability (SWAYAM)	6 weeks	1
9.	Artificial Intelligence (SWAYAM)	15 weeks	4
10.	Communication Technology in Education (SWAYAM)	15 weeks	4
11.	Knowledge Society (SWAYAM)	15 weeks	3
12.	NGO'S and Sustainable Development	15 weeks	1
13.	Counseling Psychology	12 weeks	1
14.	Gender Sensitization: Society Culture and Change	16 weeks	1
15.	Psychology of Stress, Health and Well-being	12 weeks	1
16.	Environmental Law (SWAYAM)	20 weeks	4
17.	Food Microbiology and Food Safety (SWAYAM)	15 weeks	4
18.	Intellectual Property (SWAYAM)	15 weeks	4
19.	Introduction To R (SWAYAM)	14 weeks	4
20.	Research Methodology (SWAYAM)	15 weeks	4
21.	Nanotechnology Applications in Fisheries	8 weeks	1
22.	Personality Development and Communication Skills	8 weeks	1
23.	Public Speaking	8 weeks	1
24.	Personality Development	8 weeks	1
25.	Emotional Intelligence	8 weeks	1
26.	Yoga Practices 1	12 weeks	1
27.	Yoga Practices 2	12 weeks	1
28.	Ethics: Theories and Applications	12 weeks	1
29.	Information Sources and Library Services	6 weeks	1
30.	Qualitative Research Methods and Research Writing	12 weeks	1
31.	Extension and Communication Management	12 weeks	1

FOOD TECHNOLOGY

Course Curricula for Undergraduate Programs in Food Technology UG-Certificate (Food Technology) UG-Diploma (Food Technology) B. Tech. (Food Technology)

INTRODUCTION

In an era marked by rapid population growth, changing dietary patterns, and environmental concerns, the significance of food technology cannot be overstated. Food Technology course is designed to address the multifaceted challenges facing the food industry today. It recognizes the need for a holistic approach to food technology education that encompasses theoretical knowledge, practical skills, and ethical considerations. At its core, the course aims to produce graduates who are well-equipped to address issues such as food security, safety, new product development, sustainability, and innovation.

The National Education Policy (NEP) serves as a guiding framework aimed at revolutionizing education in this critical field. This comprehensive policy not only emphasizes theoretical knowledge but also underscores the importance of practical application, interdisciplinary learning, innovation, and critical thinking.

In view of these, the restructuring of under-graduate programs in Food Technology have been carried out. More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has also been made for advanced skill development through project work or experiential learning/ incubation, etc. These activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and analytical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

One of the fundamental pillars of the program on Food Technology course is the emphasis on practical application. Recognizing the importance of hands-on learning experiences, laboratory work, and industry internships, the course has been designed to provide students with real-world exposure to the complexities of food processing, preservation, and quality assurance. By integrating practical training into the curriculum, students can develop essential skills that are crucial for success in the food industry. Two exit options, one after first year as a Certificate and the other after the second year

as Diploma in Food Technology, have been provided, so that the students can look for employment at any point of their career.

The course on Food Technology advocates for an interdisciplinary approach to education. It recognizes that food technology is inherently multidisciplinary, drawing upon principles from fields such as biology, chemistry, microbiology, engineering, and nutrition. By incorporating elements from these diverse disciplines, students gain a comprehensive understanding of food science and are better equipped to tackle complex challenges in the field.

This modified Food Technology course has far-reaching implications for the future of food. By equipping students with comprehensive knowledge, practical skills, and ethical principles, the syllabus lays the foundation for a sustainable, resilient, and equitable food system. Graduates of the program are poised to make meaningful contributions to the food industry, driving innovation, promoting food security, and ensuring the safety and integrity of the global food supply.

Entrepreneurship in food technology is an aspect that is characterized by a spirit of innovation and disruption. Entrepreneurs in this field leverage cutting-edge technologies, scientific advancements, and creative thinking to develop novel solutions that revolutionize the way we produce, process, and consume food. These entrepreneurs are driving forward-thinking initiatives that have the potential to reshape the future of food.

The details of the course structure for the Undergraduate courses in Food Technology (UG-Certificate, UG-Diploma and B. Tech.) have been prepared after having multistage in-depth deliberations and discussions with the Deans' and faculty members of the Food Technology discipline of different SAUs, stakeholders from related industries and alumni. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020.

This course on Food Technology represents a landmark initiative aimed at transforming education in this critical field. By emphasizing practical application, interdisciplinary learning, innovation, and food safety, the program seeks to empower students with the knowledge and skills needed to address the complex challenges facing the food industry. As we look towards the future, the course curricula on Food Technology holds immense promise for shaping a more sustainable, resilient, and equitable food system for generations to come.

HIGHLIGHTS

- The B. Tech. (Food technology) Program will be of 4 years, covering 182 credits, which has 176 credits (inclusive of four credits of two non-gradial courses i.e (Deeksharambh (Induction-cum-Foundation course): 2 credits and Study tour: 2 credits), offered by the parent institute. Additionally, 6 credits of online courses are to be taken by the student as per his/ her choice.
- More weightage has been given to skill development courses in first two years, semesters 1 to 4. Students have been given flexibility and choice in selection of skill development courses from a basket of multiple skill development modules offered in all the four semesters of first two years.
- The UG Certificate is being offered in three domains viz., Food Plant Operations, Food Manufacturing and Food Quality Testing for which a bouquet of courses has been offered to enhance their skill in the particular domain.
- Students will be given 4 credits of skill-based courses each in first, second, and 2 each in third and fourth semesters so that they will acquire enough knowledge and skill through hands-on training in related domain.
- The students will have flexibility and choice in selection of skill areas from a bouquet of skill enhancement modules to be offered/ listed by the parent institute. After three days common orientation on different skill enhancement modules, students will take up either one or more modules as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.
- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running the Skill Enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.
- In first year, after completing the course requirement of 45 credits of both the semesters, there is provision of extra 10 credits Internship of two months period for Industry placement/ Industry exposure/ Hands-on with local food processors/equipment manufacturers, etc. in related domain of skill acquired to get first-hand experience to become eligible for the award of UG-Certificate on exit.
- The second year has been designed with the basic engineering courses as well as fundamental courses in food technology with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of Food Technology. After satisfactory completion of the courses of 2nd year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Food Technology on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given in proper amalgamation of theory and practical to provide them hard core knowledge of the B. Tech. (Food Technology) discipline as well. In third year, the student will be taught Intensive core courses of Food Technology.

- Six credits of online courses are at the discretion of students. Students have the choice of taking online courses to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these Non-credit elective courses of 6 credits any time during the 3rd and 4th years. These courses are to be completed with satisfactory grade.
- In eighth semester of the degree program students will be offered Internship of 20 credits.
- On successfully completing the four years degree requirement, the student will be given undergraduate degree of B. Tech. (Food Technology).

Entry and Exit Options

The entry and exit options for the UG programs in Food Technology are shown in the figure 1. below.

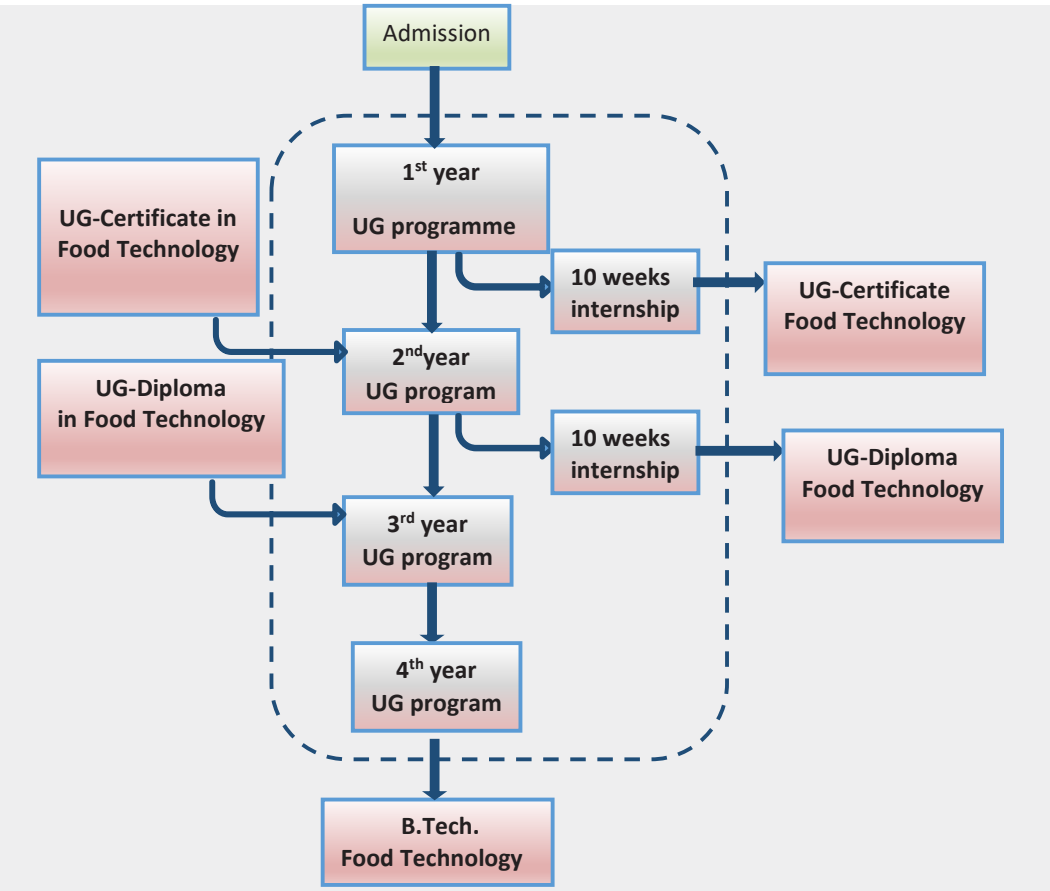

Fig.1 Entry and Exit options for the UG programs in Food Technology

1. **Eligibility for Entry into 1st year UG program:** +2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU.

Exit options

UG-Certificate in Food Technology (exit after first year and completion of 10 weeks' internship) with following specialization e.g. UG certificate in Food technology (Food Plant Operations)

a. Food Plant Operations
b. Food Manufacturing
c. Food Quality Testing

2. **UG-Diploma in Food Technology** (exit after second year and completion of 10 weeks' internship)

3. **B.Tech. (Food Technology)** (on successful completion of four-year degree requirements)

The Universities may consider allowing lateral entry for the candidates having Diploma in Food Technology (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having Diploma in Food Technology (with minimum 3 years course program after 10th or equivalent as approved by UGC/ICAR as per the provisions to be notified by the respective AU from time to time.

ACADEMIC PROGRAM

Semester wise course distribution

S. No.	Course Title	Credit hours	Total Credit hours
	First Year		
	Semester-I		
1.	*Deeksharambh* (Induction-cum-Foundation Course of 2 weeks)	2 (0+2) Non-Gradial	22 (10+12) +2 (Non-Gradial)
2.	Fundamentals of Food Processing	3 (2+1)	
3.	Workshop Technology	3 (1+2)	
4.	Basic Electrical Engineering	3 (2+1)	
5.	General Microbiology	3 (2+1)	
6.	Farming Based Livelihood System	3 (2+1)	
7.	Communication Skills	2 (1+1)	
8.	NCC-I/ NSS-I	1 (0+1)	
9.	Skill Enhancement Course- I***	2 (0+2)	
10.	Skill Enhancement Course - II***	2 (0+2)	
	Semester-II		
1.	Post-Harvest Engineering	3 (2+1)	23 (11+12)
2.	Food Chemistry I	3 (2+1)	
3.	Unit Operations in Food Processing	3 (2+1)	
4.	Food Thermodynamics	3 (2+1)	
5.	Engineering Drawing and Graphics	3 (1+2)	

S. No.	Course Title	Credit hours	Total Credit hours
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	NCC-II/NSS-II	1 (0+1)	
8.	Skill Enhancement Course - III***	2 (0+2)	
9.	Skill Enhancement Course - IV***	2 (0+2)	

Proposed Basket of Skill Enhancement Course Modules for Semester I to VI++

Discipline/ Department		Course Title	Credit hours
Food Technology	1	Introduction to Drying Technology and Dryers	2 (0+2)
	2	Introduction to Processing of Extruded Foods	2 (0+2)
	3	Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)
Food Quality	1	Introduction to Food Safety and Sanitation	2 (0+2)
	2	Introduction to Good Laboratory Practices	2 (0+2)
	3	Basic Food Analysis Laboratory Techniques	2 (0+2)
Food Engineering	1	Introduction to Electrical and Control Systems in Food Industry	2 (0+2)
	2	Introduction to Mechanical Systems in Food Industry	2 (0+2)
	3	Introduction to AutoCAD	2 (0+2)
Food Plant Operations	1	Maintenance of Food Processing Equipment	2 (0+2)
	2	Introduction to Bottling and Canning Line	2 (0+2)
	3	Introduction to Manufacturing of Bakery Products	2 (0+2)

++From Basket of Skill enhancement course modules, only one course from each discipline is to be selected per the semester as per the selected specialization of certificate. However, at least one course of other specialization viz. Food Technology, Food Engineering and Food Quality is to be taken for the Diploma course.

Student taking various SKILL ENHANCEMENT COURSES will be eligible to get a Certificate with Nomenclature as follows provided the student has selected courses as mentioned against the nomenclature of the UG-Certificate.

Nomenclature of Certificate	Skill Enhancement Courses to be selected from the respective disciplines	
	Semester-I	Semester-II
UG-Certificate in Food Technology (Food Plant Operations)	Food Engineering	Food Plant Operations
UG-Certificate in Food Technology (Food Manufacturing)	Food Technology	Food Plant Operations
UG-Certificate in Food Technology (Food Quality Testing)	Food Quality Assurance	Food Plant operations

In case a student wishes to exit at this point,

Post- II SEMESTER

Course Title	Credit hours
Internship only for exit option for award of UG-Certificate) 10 weeks	**10 (0+10)***

There is no need to do the internship if the student wishes to continue further study.

Second Year			
SEMESTER-III			
1.	Food Chemistry II	3 (2+1)	**23 (13+10)**
2.	Fluid Mechanics	3 (2+1)	
3.	Heat and Mass Transfer in Food Processing	3 (2+1)	
4.	Basic Electronic Engineering	2 (1+1)	
5.	Food Microbiology	3 (2+1)	
6.	Engineering Mathematics- I	2 (2+0)	
8.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9.	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
7.	Skill Enhancement Course-V***	2 (0+2)	
SEMESTER-IV			
1.	Fundamentals of Food Engineering	3 (2+1)	**20 (13+7)**
2.	Food Plant Sanitation	3 (2+1)	
3.	Food Quality, Safety Standards and Certification	2 (2+0)	
4.	Engineering Mathematics- II	2 (2+0)	
5.	Food Plant Utilities and Services	3 (2+1)	
6.	Entrepreneurship Development and Business Management	3 (2+1)	
7.	Personality Development	**2 (1+1)**	
8.	Skill Enhancement Course-VI***	2 (0+2)	
Student taking various SKILL ENHANCEMENT COURSES can exit here to get a UG-Diploma in Food Technology			

Post- IV SEMESTER

Course Title	Credit hours
Internship (only for exit option for award of UG- Diploma)	**10 (0+10)***

There is no need to do the internship if the student wishes to continue further study.

Third Year			
SEMESTER-V			
1.	Food Biochemistry and Nutrition	3 (2+1)	**22 (14+8) +2** (Non-Gradial)
2.	Processing Technology of Cereals	3 (2+1)	
3.	Processing Technology of Fruits and Vegetables	3 (2+1)	
4.	Food Packaging Technology and Equipment	2 (1+1)	
5.	Processing of Spices and Plantation Crops	3 (2+1)	
6.	Food Storage Engineering	3 (2+1)	
7.	Project Preparation and Management	2 (1+1)	
8.	Agricultural Marketing and Trade	3 (2+1)	
9.	Study tour (10-12 days during the semester)	2 (0+2) NG	

SEMESTER-VI			
1.	Food Additives and Preservatives	2 (1+1)	**21 (13+8)**
2.	Sensory Evaluation of Food Products	2 (1+1)	
3.	Processing Technology of Legumes and Oilseed	3 (2+1)	
4.	Food Refrigeration and Cold Chain	3 (2+1)	
5.	Processing of Meat, Fish and Poultry Products	3 (2+1)	
6.	Processing Technology of Beverages	3 (2+1)	
7.	Bakery, Confectionary and Snack Products	3 (2+ 1)	
8.	Processing Technology of Liquid Milk	2 (1+1)	
Fourth Year			
SEMESTER-VII			
1.	Food Process Equipment Design	3 (2+1)	**20**
2.	Processing Technology of Dairy Products	3 (2+1)	
3.	ICT Applications in Food Industry	3 (1+2)	
4.	Seminar	1 (0+1)	
5.	Elective Courses	10	

Student has to complete 20 credits in this semester. Courses 1-4 (10 credits) are compulsory. (Minimum 10 credit hours from this Suggestive list of courses should be opted as Elective Courses)

ELECTIVE COURSES

1.	Design and Formulation of Foods	3 (2+1)
2.	Industrial Microbiology	3 (2+1)
3.	Introduction to Food Biotechnology	3 (2+1)
4.	Business Management and Economics	2 (2+0)
5.	Statistical Methods and Numerical Analysis	2 (1+1)
6.	Instrumentation and Process Control in Food Industry	3 (1+2)
7.	Instrumental Techniques in Food Analysis	2 (1+1)
8.	Traditional Indian Dairy Products	2 (1+1)
9.	Ice-cream andFrozen Desserts	3 (2+1)
10.	Energy Conservation and Management	2 (1+1)
11.	Applications of Renewable Energy in Food Processing	2 (1+1)
12.	Food Plant Design and Layout	3 (2+1)
13.	Waste and By-Products Utilization	3 (2+1)

SEMESTER-VIII			
1	Student Ready / Internship (at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)	**20 (0+20)**

#CNC-Compulsory non-gradial course

*** From the available basket of skill enhancement modules

Department wise course distribution

S. No.	Course Title	Credit hours
Department of Food Technology		
1	Fundamentals of Food Processing	3 (2+1)
2	Processing Technology of Fruits and Vegetables	3 (2+1)
3	Processing Technology of Liquid Milk	2 (1+1)
4	Food Packaging Technology and Equipment	2 (1+1)
5	Processing Technology of Cereals	3 (2+1)
6	Processing Technology of Legumes and Oilseed	3 (2+1)
7	Processing Technology of Dairy Products	3 (2+1)
8	Processing of Meat, Fish and Poultry Products	3 (2+1)
9	Bakery, Confectionary and Snack Products	3 (2+ 1)
10	Processing of Spices and Plantation Crops	3 (2+1)
16	Sensory evaluation of Food Products	2 (1+1)
11	Processing Technology of Beverages	3 (2+1)
12	Internship (at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)
Skill Enhancement Courses		
1	Introduction to Drying Technology andDryers	2 (0+2)
2	Introduction to Processing of Extruded Foods	2 (0+2)
3	Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)
Department of Food Engineering		
1	Workshop Technology	3 (1+2)
2	Engineering Drawing and Graphics	3 (1+2)
3	Basic Electrical Engineering	3 (2+1)
4	Food Thermodynamics	3 (2+1)
5	Post-Harvest Engineering	3 (2+1)
6	Fluid Mechanics	3 (2+1)
7	Heat and Mass Transfer in Food Processing	3 (2+1)
8	Basic Electronic Engineering	2 (1+1)
9	Unit Operations in Food Processing	3 (2+1)
10	Fundamentals of Food Engineering	3 (2+1)
11	Food Refrigeration and Cold Chain	3 (2+1)
12	Food Storage Engineering	3 (2+1)
13	Food Process Equipment Design	3 (2+1)
14	Instrumentation and Process Control in Food Industry	3 (1+2)
Skill Enhancement Courses		
1	Introduction to Electrical and Control Systems in Food Industry	2 (0+2)
2	Introduction to Mechanical Systems in Food Industry	2 (0+2)
3	Introduction to AutoCAD	2 (0+2)

S. No.	Course Title	Credit hours
Department of Food Quality Assurance		
1	Food Chemistry I	3 (2+1)
2	Food Chemistry II	3 (2+1)
3	General Microbiology	3 (2+1)
4	Food Microbiology	3 (2+1)
5	Industrial Microbiology	3 (2+1)
6	Food Biochemistry and Nutrition	3 (2+1)
7	Food Plant Sanitation	3 (2+1)
8	Introduction to Food Biotechnology	3 (2+1)
9	Instrumental Techniques in Food Analysis	2 (1+1)
10	Food Additives and Preservatives	3 (2+1)
11	Food Quality, Safety Standards and Certification	2 (2+0)
	Skill Enhancement Courses	
1	Introduction to Food Safety and Sanitation	2 (0+2)
2	Introduction to Good Laboratory Practices	2 (0+2)
3	Basic Food Analysis Laboratory Techniques	2 (0+2)
Department of Food Business Management		
1	Business Management and Economics	2 (2+0)
2	Engineering Mathematics- I	2 (2+0)
3	Engineering Mathematics- II	2 (2+0)
4	Statistical Methods and Numerical Analysis	2 (1+1)
5	ICT Applications in Food Industry (Informatics)	3 (1+2)
6	Project Preparation and Management	2 (1+1)
	Common Courses	
1	Foundation Program (3 weeks)	4 (0+4) Non-Gradial
2	Farming Based Livelihood System	3 (2+1)
3	Communication Skills	2 (1+1)
4	Personality Development	
5	Environmental Science and Disaster Management	3 (2+1)
6	Entrepreneurship Development and Business Management	3 (2+1)
7	Agricultural Marketing and Trade	3 (2+1)
Department of Food Plant Operations		
1	Food Plant Utilities andServices	3 (2+1)
	Skill Enhancement Courses	

S. No.	Course Title	Credit hours
1	Maintenance of Food Processing Equipment	2 (0+2)
2	Introduction to Bottling andCanning Line	2 (0+2)
3	Introduction to Manufacturing of Bakery Products	2 (0+2)
4	Internship (only for exit option for award of UG-Certificate) 10 weeks	**10 (0+10)***
5	Internship (only for exit option for award of UG- Diploma)	**10 (0+10)***
6	Study tour (10-12 days during the semester)	2(0+2) Non-gradial

Summary of Credit Distributions

Categories of Courses		Credit Hours
Core Courses (Major and Minor)	:	117
Common Courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship	:	20
MOOCs/Online Courses (Non-gradial)	:	6**
Grand Total	**:**	**172+6****

Table 1 Credits Allocation Scheme of UG programs B. Tech (Food Technology) (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)		
II	15	---	3(6)	1(3)	4	-	23	-	10(12)	
III	16	----	3 (10)	2(8)	2	-	23			
IV	13	3(5)		2(7)	2	-	20	-	10(13)	**6**
V	19	3(9)	-	-	-	-	22	2(11)		
VI	21	-	-	-	-	-	21	-		
VII	20	-	-	-	-	-	20	-		
VIII		-	-	-	-	20	20	-		
Total	**116**	**9**	**6**	**8**	**12**	**20**	**171**	**4**		**6**

Note: The credit hours mentioned in the table includes both theory and practical.

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Meditation
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics and artificial intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

DETAILED SYLLABI

Semester I

Deeksharambh (2 weeks Program) 2 (0+2) NG

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

- Help for cultural Integration of students from different backgrounds,
- Know about the operational framework of academic process in university
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Students shall be made aware about the field of food processing, the industry, production systems, importance of nutrition, packaging, quality issues involved, shelf life and the legal standards available using simple day to day examples.
- In addition, the students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that are existing in this area of food processing technology.
- The students will be encouraged to develop deep interest in the field in which now they have entered. It will also make it clear about the skill enhancement courses that they need to choose during the study to decide their future.
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
- Activities to enhance cultural Integration of students from different backgrounds.
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Fundamentals of Food Processing 3 (2+1)

Objectives

1. Gain an understanding of the perishability of food and causes for food spoilage
2. Have an idea of the basic methods of preservation of food
3. Knowledge about non thermal processing of food

Theory

Food: Definition and Functions, Classification of foods, sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation.

Food processing: Introduction, levels and techniques; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality.

Preservation by heat treatment: Principle, process and equipment for blanching, canning, pasteurization, sterilization.

Preservation by use of low temperature: Principle, methods, equipment.

Preservation by drying, dehydration and concentration: Principle, methods, equipment.

Preservation by irradiation: Principle, methods, equipment.

Preservation by chemicals- antioxidants, mould inhibitors, antibodies, acidulants, Hurdle technology etc.

Preservation by fermentation: Principles, methods, equipment.

Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc.

Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze-drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

Suggested Readings

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8. Stavros Y. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.
9. Tewari, G. and Juneja, V.K. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
10. Zeuthen, P. and Bùgh-Sùrensen, L. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.

Workshop Technology 3 (1+2)

Objectives

1. Gain an understanding about different type of material and their measurement
2. Have an idea of the basic methods involved in repair and maintenance of equipment
3. Knowledge about skills related to welding, blacksmith, carpentry, sheet metal, machining etc.

Theory

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications.

Safety measures in workshop; Indian Factory Acts on safety; Measuring and Gauging: Basic measuring instruments and gauges.

Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.

Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipment; Gas welding and cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost.

Smithy and forging: Introduction to different tools and their uses, different forging operations.

Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.

Machinery: Introduction to various workshop machines (1) Lathe, (2) power hacksaw, (3) Shaper and planner, (4) Drilling, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for shaping, slotting and planning operations, work holding and tool holding devices.

Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Practical

Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipment, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

Suggested Readings

1. Chapman, W.A.J. 1989. Workshop Technology. Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi.
2. Hazra Choudari, S.K. and Bose, S.K. 1982. Elements of Workshop Technology. Vols. I and II. Media Promoters and Publishers Pvt. Ltd., Mumbai.
3. Raghuwansi, B.S. 1996. A Course in Workshop Technology. Vols. I and II. Dhanpet Rai and Sons, New Delhi.

Basic Electrical Engineering 3 (2+1)

Objectives

1. Differentiate between single and three phase connection
2. Have an idea of the basic measuring electrical current and its quality
3. Knowledge about application of wiring and connections

Theory

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, Magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents, phase relations and vector representation, AC through resistance, inductance and capacitance, AC series and parallel circuits, Simple R-L, R-C and R-L-C circuits; Engineering Circuit Analysis: Current, Voltage, Power, Circuit elements, Ohm's law.

3 Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement.

Transformer: Principle of working, construction of single-phase transformer, core type, shell type transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test.

Single phase induction motor: Double field revolving theory, characteristics, phase split, shaded pole motors.

Poly phase induction motor: Construction, operation, equivalent circuit, production of rotating field, effect of rotor resistance, torque equation, starting and speed control methods.

Alternators: Principle of operation, types of rotors, EMF equation.

D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics. D.C. Motors, their starting, speed controls and characteristics.

Electric Power Economics: Maximum demand charge, Load factor, Power factor and power factor improvement.

Measuring Equipment's: Classification, Characteristics of different electrical measuring systems and equipment's.

Electrical Wiring: system of wiring, domestic wiring installation, industrial electrification.

Protection devices: Earthing, Circuit protection devices, fuses, ELCB and relays.

Practical

Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Problems on Industrial Electrification. Study of various circuit protection devices. Study of various measuring instruments.

Suggested Readings

1. Theraja, B.L. and Theraja, A.K. 2005. A Textbook of Electrical Technology. Vol. II. S. Chand and Company Ltd., New Delhi.
2. Toro, V.D. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.

General Microbiology 3 (2+1)

Objectives

1. Identify the micro-organisms, their structure and growth characteristics
2. Techniques for cultivation and preservation and control

Theory

Scope and history of microbiology: (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.), Place of Microorganisms in living world; Groups of microorganisms; Applied area of microbiology,

Classification and identification of micro- organism; Major Characteristics of Microorganisms, Methods of classification of bacteria.

Microscopy: Introduction to microscope; Component of microscope; Types of microscope and Microscopic techniques.

Microbial Ultra Structure and Functions: Morphological features; Structures external to cell wall, Cell wall; Structures internal to cell wall.

Cultivation and preservation of micro-organisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for micro-organisms.

Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: growth curve, continuous culture, synchronous culture; Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

Control of microorganisms: Physical and Chemical agents.

Bacterial genetics.

Structure and functions of DNA and RNA; Overview of replication and regulation.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule- staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Suggested Readings

1. Pelczar Jr. M.J., Chan, E.C.S. and Krieg, N.R. 1998. Microbiology. 5th edn. Tata McGraw-Hill Education, New Delhi.
2. Tortora, G.J., Funke, B.R. and Case, C.L. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
3. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th edn. McGraw-Hill Higher Education, NY, USA.

Farming based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different

indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry, duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming- based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India
2. Ashley, C., Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar].
3. Carloni, A. (2001). Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA.
5. Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar

7. Panwar et al. (2020). Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. (2016). Farming System and Sustainable Agriculture. Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. (2015). Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and Walia, U. S. (2020). Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Brandreth, Gyles, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.

5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

National Cadet Corps (NCC-I) 1 (0+1)

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) 1 (0+1)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include

orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS.
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Post-Harvest Engineering 3 (2+1)

Objectives

1. To understand the basic post-harvest operations
2. Gain an understanding of various engineering properties
3. Differentiate between different types of material handling systems

Theory

Overview of Post-Harvest Technology.

Concept and science, Introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses, reasons for losses, importance of loss reduction, Post-Harvest Handling operations.

Water Activity; Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture.

Engineering Properties of Food Materials; physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement.

Cleaning; Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling.

Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance

Magnetic separator, destoners, electrostatic separators, pneumatic separator.

Decorticating and Shelling; Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.

Milling, polishing, grinding, milling equipment, de-huskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement.

Materials Handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices.

Study of different Material Handling systems; Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement; Pneumatic conveying system: types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Suggested Readings

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
3. Chakraverty, A. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Chakraverty, A. and Singh, R.P. 2014. Post Harvest Technology and Food Process Engineering.

CRC Press, Boca Raton, FL, USA.

5. Dash, S K, Bebartta, J P and Kar, A. 2012. Rice Processing and Allied Activities. Kalyani Publishers.
6. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
7. Green, D.W. and Perry, R.H. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
8. Hall, C. W. and Davis, D. C. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. Henderson, S.M. and Perry, R.L. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.
10. Mohsenin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
11. Mohsenin, N.N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
12. Mohsenin, N.N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, NY.
13. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
14. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

Food Chemistry I 3 (2+1)

Objectives

1. Learn the chemical aspects of food and bio- materials and its importance in food processing
2. Gain an understanding of various water and macro- molecules
3. Have an idea of about the effect of processing on these biomolecules

Theory

Water; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems.

Carbohydrates; Monosaccharaides, disaccharides and polysaccharides, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates.

Proteins in foods: Proteins: Classification, structure and properties, Proteins and nutrition, Functional properties of proteins, Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein.

Lipids in foods: Classification, structure and properties of lipids; Role and use of lipids/ fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal

decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, use of oils and fats in food formulation.

Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques, chemical aspects of lipids, antioxidants.

Practical

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases.

Suggested Readings

1. Brady, J.W. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.
2. Belitz, H. D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg.
3. Fennema, O.R. 1996. Food Chemistry, 3rd edn. Marcel Dekker, Inc., New York, USA.
4. Meyer, L.H. 1974. Food Chemistry. The AVI Publishing Co Inc., Connecticut, MA, USA.

Unit Operations in Food Processing 3 (2+1)

Objectives

1. To familiarize with Commonly involved unit operations in food processing
2. Differentiate between blanching, pasteurization and sterilization
3. Application of these unit operations in food product development

Theory

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation.

Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices.

Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, Freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen

food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.

Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations.

Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization.

Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation, distillation of wines and spirits.

Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment.

Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment.

Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger.

Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package.

Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification.

Practical

Study of working principle open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar.

Study of freezers/ Design problems on freezers; To study freezing of foods by different methods IQF freezing; Determination of freezing time of a food material; To study simple distillation process and determine the rate of distillation; To study the process of roasting/ To study the effect of time-temperature combination on roasting; Determination of oil uptake by the food product during frying.

To determine the efficacy of a blanching process; time-temperature combination for a blanching process; efficacy of a sterilization process; Determination of F value for a product in can/ retortable pouch; Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators.

Suggested Readings

1. Earle, R.L. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science and Technology, New Zealand.
2. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd edn. CRC Press, Boca Raton, FL, USA.
3. Geankoplis, C.G. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
4. Ibarz, A. and Barbosa-Cánovas, G. V. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
5. McCabe, W.L., Smith, J. and Harriott, P. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
6. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth–Heinemann, Oxford, UK.
8. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science andBusiness Media, New York, USA.
9. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
10. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
11. Treybal, R.E. 1980. Mass Transfer Operations, 3rd edn. McGraw-Hill Book Company, Auckland, USA.
12. Valentas, K.J., Rotstein, E. and Singh, R.P. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

Food Thermodynamics 3 (2+1)

Objectives

1. Have an idea about basic concepts of energy and laws of thermodynamics
2. Knowledge about thermodynamic cycles and their application
3. Knowledge about psychrometric properties of air and its application in drying and other food applications

Theory

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat.

First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis.

Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, entropy, availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule.

Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle.

Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms.

Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity.

Boilers and steam generation: fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Practical

Demonstration and application of zeroth law of thermodynamics; first law of thermodynamics; and second law of thermodynamics. Study of different types of boilers; boiler mounting and accessories; various types of burners and fuels; Determination of calorific values of different fuels. Study of vapour compression refrigeration test rig; heat pump; properties of wet, dry, saturated and superheated steam; Use of steam tables and Moiler charts; dryness fraction of steam; use of psychometric chart for humidification, dehumidification, heating and drying; Determination of thermodynamic properties on psychrometric charts; study of steam trap and steam line layouts; Visit to food plant with steam utilization.

Suggested Readings

1. Brooker, D.B., Bakker-Arkema, F.W. and Hall, C.W. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
4. Nag, P.K. 2005. Engineering Thermodynamics, 3rd edn. Tata-McGraw-Hill Education, New Delhi.
5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
6. Rajput, R.K. 2007. Engineering Thermodynamics, 3rd edn. Laxmi Publications (P) Ltd., Bangalore.

7. Smith, J.M., Van Ness, H.C. and Abbott, M.M. 2005. Introduction to Chemical Engineering Thermodynamics, 7th edn. McGraw-Hill, Inc., NY, USA.

Engineering Drawing and Graphics 3 (1+2)

Objectives

1. To gain an understanding about drawing as per engineering requirement
2. Have an idea of the isometric, orthographic views and projection
3. Knowledge about Computer Aided Design

Theory

Definition of projection, Principle of projection, Methods of projections, Orthographic projection, plane of projection, First and third angle of projection.

Different methods of dimensioning; Isometric scale, Isometric axes, Isometric projection, Preparation of working drawing from models and isometric views.

Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints.

Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Drawing of missing views. Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

Practical

Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

Suggested Readings

1. Bhat, N.D. and Panchal, V.M. 1995. Machine Drawing. Charotar Publishing House, Anand.
2. Bhat, N.D.1995. Elementary Engineering Drawing. Charotar Publishing House, Anand.
3. Lee, K. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.
4. Zeid, I. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (i) Air pollution. (ii) Water pollution. (iii) Soil pollution. (vi) Marine pollution. (v) Noise pollution. (vi) Thermal pollution h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/ forest/ grassland /hill /mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness.

Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De. A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti. P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India (In Press).
5. Prasanthrajan M, Mahendran, P. P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition.
6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

National Cadet Corps (NCC-II) 1 (0+1)

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defence obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) **1 (0+1)**

- Importance and role of youth leadership.
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies.
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs.
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations.
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Semester III

Food Chemistry II **3 (2+1)**

Objectives

1. Study chemical aspects of food and bio- materials and their importance in food processing
2. Gain an understanding of chemicals responsible for flavour, pigments and colorants
3. Have an idea of about the effect of processing on these biomolecules
4. Gain the knowledge about role of enzymes in food processing

Theory

Philosophy and definitions of flavour, Chemistry of food flavour; flavourmatics/ flavouring compounds, sensory assessment of flavour, technology for flavour retention.

Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs.

Popular colors used in food and their fictional properties; Regulatory use of regulatory dyes; Colour losses during thermal processing.

Vitamin functions in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins, optimization and retention of vitamins.

Important minerals and their function in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals.

Various anti-nutritional factors their mode of action and inactivation.

Enzymes in Food Processing: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid, enzyme specificity, Michaelis-Menten equation, regulation mechanism.

Practical

Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron; Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids), C, E; Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables.

Suggested Readings

1. Belitz, H.-D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg.
2. Fennema, O.R. 1996. Food Chemistry, 3rd edn. Marcel Dekker, Inc., New York, USA.

Fluid Mechanics 3 (2+1)

Objectives

1. Get idea about types of fluids and their properties
2. Gain knowledge about the flow behaviour of the fluids
3. Differentiate about various types of pumps and their use in food processing

Theory

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces, Flow behavior of viscous fluids; Compressible and non-compressible fluids; Surface tension, capillarity, Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedes principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries; Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps.

Practical

Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes; Study and operation of centrifugal and other pumps used in dairy and food processing plants.

Suggested Readings

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N. 2002. Transport Phenomena, 2nd edn. John Wiley and Sons, Inc., New York, USA.
2. Çengel, Y. A. and Cimbala, J.M. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.
3. Finnemore, E.J. and Franzini, J.B. 2002. Fluid Mechanics with Engineering Applications, 10th edn. McGraw-Hill, Inc., New York, USA.
4. Munson, B.R., Young, D.R. and Okiishi, T.H. 2002. Fundamentals of Fluid Mechanics, 4th edn. John Wiley and Sons, Inc., New York, USA.
5. Nevers, N.D. 1991. Fluid Mechanics for Chemical Engineers. McGraw-Hill, Inc., New York, USA.
6. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Streeter, V.L. 1962. Fluid Mechanics, 3rd edn. McGraw-Hill Book Co., Inc., Boston, USA.
8. White, F.M. 2010. Fluid Mechanics, 7th edn. McGraw-Hill Book Co., Inc., Boston, USA.

Heat and Mass Transfer in Food Processing 3 (2+1)

Objectives

1. Have knowledge about the mechanism of heat and mass transfer
2. Get knowledge of dimensionless numbers involved in heat and mass transfer
3. Differentiate between different types of heat exchangers

Theory

Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer, food properties measurements and errors; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with

negligible internal resistance and in various geometries; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heisler charts and calculations; Heat transfer to flowing fluids; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Efficiency and NTU analysis; Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Practical

Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products; Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer; mass transfer coefficient in foods; glass transition temperature of food sample; mass transfer during leaching process.

Suggested Readings

1. Cao, E. 2010. Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
2. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
3. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
4. Holman, J.P. 2010. Heat Transfer, 10th edn. McGraw-Hill Book Co., Boston, USA.
5. Lienhard IV, J.H. and Lienhard V, J.H. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
6. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
7. Özişik, M.N. 1993. Heat Conduction, 2nd edn. John Wiley and Sons, NY, USA.
8. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
9. Rajput, R.K. 2008. Heat and Mass Transfer. S. Chand and Co., New Delhi
10. Richardson, J F., Harker, J.H. and Backhurst, J.R. 1999. Coulson and Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6th edn. Butterworth–Heinemann, Oxford, UK.

11. Treybal, R.E. 1980. Mass Transfer Operations, 3rd edn. McGraw-Hill Book Company, Auckland, USA.

Basic Electronics Engineering 2 (1+1)

Objectives

1. Study basic concepts of electronics and their relevance in food industry
2. Get idea about various electronic components
3. Knowledge about electronic device and their concept in measurement

Theory

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); voltage multiplier, filter circuits; Bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiters, OP-AMP voltage regulators; Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits binary ladder D/A converter and A/D converter; Transducers: Classification, selection criteria, characteristics, sensors and actuators construction, working principles, applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges, capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers, variable parameter type, digital, actuating and controlling devices.

Practical

Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as an active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

Suggested Readings

1. Anand Kumar. 2014. Fundamentals of Digital Circuits. PHI Pvt. Ltd., New Delhi.
2. Gupta, S. 2002. Electronic Devices and Circuits. Dhanpat Rai Publications (P) Limited, New Delhi.
3. Mehta, V.K. and Mehta, R. 2008. Principles of Electronics. S. Chand and Co., New Delhi.
4. Roy, D.C. 2003. Linear Integrated Circuits. John Wiley International, NY.
5. Sawhney, A.K. 2010. Course in Electrical and Electronics Measurements and Instrumentation. Dhanpat Rai Publications (P) Limited, New Delhi.

Food Microbiology 3 (2+1)

Objectives

1. Microbiology of different foods
2. Food borne toxins
3. Understand spoilage of food

Theory

Importance and significance of microbes in food science; Sources of microorganisms in foods and their effective control; Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc. Normal Microbiological quality of Foods and its significance: milk and milk products, fruits and vegetables, cereals and cereal products, meat and meat products, fish and other sea foods, poultry and eggs; sugar and sugar products, slats and spices and canned foods; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Shelf life: Calculation of shelf life, Shelf-life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products; Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins; Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.

Practical

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation; Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation; Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation; Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

Suggested Readings

1. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, 3rd edn, The Royal Society of Chemistry, Cambridge, UK.
2. Banwart, G.J. 1989. Basic Food Microbiology, 2nd edn. Chapman and Hall, New York, USA.
3. Frazier, W.C. and Westfoff, D.C. 1987. Food Microbiology, 4th edn. Tata McGraw-Hill Education, New Delhi.
4. Jay, J.M. 2000. Modern Food Microbiology, 6th edn. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.

5. Ray, B. and Bhunia, A. 2008. Fundamental Food Microbiology, 4th edn., CRC press, Taylor and Francis Group, USA.

Engineering Mathematics-I 2 (2+0)

Objectives

1. Gain knowledge about curves and their expression in mathematical form
2. Develop equations for a process and its integration

Theory

Taylor's and Maclaurin's expansions, indeterminate form: Curvature, asymptotes, tracing of curves function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima; Reduction formulae, Gamma and Beta functions: Rectification of standard curves, volumes and surfaces of revolution of curves Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume; Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation; Differential equations of higher orders, methods of finding complementary functions and particular integrals, Method of variation of parameters simultaneous linear differential equations with constant coefficients, Cauchy's and Legendre's linear equations, Bessel's and Legendre's differential equations series solution techniques; Differentiation of vectors, scalar and vector point functions, vector differential operator Del: Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, Identities involving Del, second order differential operator Line, Surface and volume integrals, Stoke's, divergence and Green's theorems.

Suggested Readings

1. Grewal, B.S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. A Textbook of Vector Calculus. S. Chand and Co. Ltd. New Delhi

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical

analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.

3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri Informatics by Mahapatra, Subrat Ketal, Jain Brothers Publication.

Physical Education, First Aid,Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems andits Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga.

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of yoga in sports.
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid

related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester IV

Fundamentals of Food Engineering 3 (2+1)

Objectives

1. Understand basic concepts of engineering principals applied to food
2. Differentiate between drying and dehydration and different types of dryers
3. knowledge about basic operations like size reduction, mixing, separation

Theory

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foam-mat dryers. Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping). Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids. Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine. Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids. Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

Practical

Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer; Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of centrifugal separator; Study of freeze dryer and freeze-drying process; Study on osmosis in fruits;

Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultra-filtration/membrane separation process.

Suggested Readings

1. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
4. Mohsenin, N. N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, New York.
5. Mohsenin, N. N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
6. Mohsenin, N. N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
7. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd
8. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth–Heinemann, Oxford, UK.
9. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.

Food Plant Sanitation 3 (2+1)

Objectives

1. Importance of sanitation and hygiene and its application to food
2. Gain knowledge of Hazard Analysis and Critical Control Point
3. Learn good manufacturing practices

Theory

Sanitation and food industry: Sanitation, sanitation laws, regulations, and guidelines, establishment of sanitary Practices. Foodborne bioterrorism: Potential risks and protection measures for bioterrorism. The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures. The Relationship of allergens to sanitation: Food allergens and its control measures. Food contamination sources: Sources of contamination, contamination of foods, protection against contamination. Personal hygiene and sanitary food handling: Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility. Cleaning compounds and sanitizers: Classification, selection of cleaning compounds and sanitizers, CIP and COP, handling and storage, precautions. Pest and Rodent Control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management. Sanitary design and construction for food processing: Site selection,

site preparation, building construction considerations, processing and design considerations, pest control design. Waste product handling: solid waste and liquid waste management. Role of HACCP in sanitation: Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices.

Practical

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices (GMPs) and personal hygiene; Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test; Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.

Suggested Readings

1. Cramer, M.M. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.
2. Hui, Y.H., Bruinsma, B.L., Gorham, J.R., Nip, W.-K., Tong, P.S., and Ventresca, P. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.
3. Mitchell, R. and Gu, J. D. 2010. Environmental Microbiology, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
4. Marriott, N.G. and Gravani, R.B. 2006. Principles of Food Sanitation, 5th edn. Springer Science and Business Media, Inc., NY, USA.
5. Pepper, I.L. and Gerba, C.P. 2005. Environmental Microbiology: Laboratory Manual, 2nd edn. Elsevier Academic Press, Amsterdam.

Food Quality, Safety Standards and Certification 2 (2+0)

Objectives

1. To familiarize the students with quality and safety of food and the standards and certification available
2. Understand quality and its assessment
3. Learn different food laws and FSMS 22000

Theory

Introduction: Definition, its role in food industry, Quality attributes; Quality Defects: Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects. Measurement of defects by different techniques; Quality Assessment; Quality assessment of food materials on the basis of sensory evaluation, Physical, chemical microbiological methods; Quality of products during processing and after processing; Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Role of

QC and QA Quality: Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries; Quality Improvement Total Quality management: Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality.

Food Laws; Food Laws and Standards: National and International food laws. Mandatory and voluntary food laws. Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities. AGMARK, BIS, FPO, Weights and Measures Act, CODEX; Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO –standards and certification process Weights and Measures Act and Packaged commodity rules; Role of CODEX in food safety and standards, Food safety issues and risk analysis; FSMS 22000, Food Safety Management Systems, ISO 22000 – 2005 and other Global Food safety management systems. Principles, implementation; documentation, types of records; Auditing, certification procedures, certifying bodies, accrediting bodies.

Suggested Readings

1. Alli, I. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.
2. Hester, R.E. and Harrison, R.M. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK
3. Schmidt, R.H. and Rodrick, G.E. 2003. Food Safety Handbook. John Wiley and Sons, Inc., Hoboken. New Jersey, USA.

Engineering Mathematics-II 2 (2+0)

Objectives

1. To familiarize the students with basic concept of mathematics
2. Gain knowledge about matrix and their transformation
3. Develop partial differential equations and their applications

Theory

Elementary transformation and rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix; Consistency and solution of linear equations; Eigen value and vectors, Cayley-Hamilton theorem; Linear and orthogonal transformations; Diagonalization of matrices, Bilinear, Quadratic forms; Limit, continuity, derivative of function of complex variable; Analytical function, C-R equations, conjugate function, harmonic functions; Fourier series: Infinite series and its convergence, periodic function, Euler's formulae for calculating Fourier coefficients, Dirichlet's conditions; Fourier series of functions with arbitrary period; Fourier series of odd and even functions; Half range sine and cosine series, Harmonic analysis; Formation of partial differential equations; Lagrange's linear equation; Higher order linear partial differential equation with constant coefficients; Solution of non-linear partial differential equation (Charpit's method); Application of partial differential equations: One dimensional wave e.g., one dimensional heat equation, two dimensional steady state heat equation i.e. Laplace equation.

Suggested Readings

1. Ramana, B.V. 2008. Engineering Mathematics. Tata McGraw-Hill Book Co., New Delhi.
2. Grewal, B.S. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
3. Narayan, S. 2004. A Textbook of Matrices. S. Chand and Co. Ltd., New Delhi.

Food Plant Utilities and Services 3 (2+1)

Objectives

1. Gain knowledge of various Utilities and services required in a food processing plant
2. Understanding working of different services
3. Understand cleaning, maintenance and trouble shooting

Theory

Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing; Electrical System- Introduction to electric power supply systems, electrical billing, electrical load management and maximum demand control, power factor improvement and benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system. Electrical motors- Types, losses in Introduction motor, motor efficiency, factors affecting motor performers, performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Compressed air system - Requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and efficiency. HVAC and Refrigeration system - Requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and saving opportunities. Vapor absorption refrigeration system: Working principle, types and comparison with VCR system, saving potential; Fans and blowers - Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, Pumps and pumping systems- Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. DG set system- Requirement, introduction, factors affecting selection; Fuels and combustion - Introduction to fuels; properties of fuel oil, coal and gas; storage; handling and preparation of fuels; principles of combustion, combustion of oil, coal and gas; draft system. Boilers- Boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities; Steam system - Properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings; Waste heat recovery - Classification, advantages and application, commercially viable waste heat recovery devices, saving potential; Other utilities and services - Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system.

Practical

Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities.; electrical power supply system, billing and load estimation; Motors and variable speed drives specification, selection, performance terms and definitions; compressed air system components and

performance terms and definitions; refrigeration and HVAC system components, performance terms and definitions and load estimation of a plant; fans and blowers, types, specification, performance terms and definitions. Pumps types, specification, selection, performance terms and definitions; plant lighting system and their components; DG system their specification and selection; combustion of oil, gas and coal; boiler performance terms and assessment. Study on cost of steam; waste heat recovery devices. Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger (Shell and tube, PHE, run around coil exchanger, direct contact HX), Waste heat recovery boilers, Heat pumps and Thermo compressor. ClP system components; water treatment plant; effluent treatment plant; fire control operations and use of fire extinguishers.

Suggested readings

1. Energy Efficiency and Management in Food Processing Facilities by Lijun Wang. Published by CRC Press, 2008.
2. Energy-saving Techniques for the Food Industry by M. E. Casper. Published by Noyes Data Corp., 1977.
3. Chilton's Food Engineering. Published by Chilton Co., 1979.
4. A Survey of Water Use in the Food Industry by W. E. Whitman, S. D. Holdsworth. Published by British Food Manufacturing Industries Research Association.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /

accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai,Vasant. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
3. Desai V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
4. Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
6. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
7. Mehra P. 2016. Business Communication for Managers. Pearson India, New Delhi.
8. Pandey M. and Tewari D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
10. Singhal R.K. 2013. Entrepreneurship Development and Management, Katson Books.
11. Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.

Personality Development 2 (1+1)

Objectives

1. To make students realize their potential strengths
2. To cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. DK Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. DK Publishing.
4. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
6. Mile, D.J., 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development (6th edn). Belmont, CA: Wadsworth

Semester V

Food Biochemistry and Nutrition 3 (2+1)

Objectives

1. Gain an understanding of nutrition and diets
2. Understand and learn metabolic pathways for different biomolecules in human body

Theory

Concepts of Food and Nutrition; Functions of food; Basic food groups; nutrients supplied by food; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Mechanism of Enzyme action; Introduction to enzyme and characteristics, coenzymes, kinetics and mechanism of enzyme action; Derivation of Michaelis- Menten Equation, Enzyme inhibition by pH, allosteric enzymes; Nucleic acids, structures of various components of DNA and RNA.

Nutrients; Functions, sources, digestion, absorption, assimilation, transport of carbohydrates; Functions, sources, digestion, absorption, assimilation, transport of proteins; Functions, sources, digestion, absorption, assimilation, transport of fats; Metabolism of carbohydrates.

Introduction to carbohydrates metabolism, glycolysis, TCA cycle; Electron transport chain, oxidative and substrate level phosphorylation; Metabolism of Lipids; Introduction to lipid metabolism, β-oxidation of long chain fatty acids, Ketosis, breakdown of phospholipids; Biosynthesis of fatty acids, triglycerides and phospholipids; Introduction to protein metabolism, transamination; Deamination and decarboxylation; Fixation of Nitrogen, Urea Cycle; Functions, sources, absorption, deficiency of macrominerals, microminerals and trace minerals; Functions, sources, absorption,

deficiency of Vitamins A &D, Vitamins E and K and water-soluble vitamins Information about hormones and relation between vitamins and hormones.

Practical

Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates; Qualitative and quantitative determination of amino acids; Qualitative and quantitative determination of proteins; Qualitative and quantitative determination of lipids; Qualitative and quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pka of acid; Determination of pI for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of β-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.

Suggested Readings

1. Berdanier, C.D., Feldman, E.B. and Dwyer, J. 2008. Handbook of Nutrition and Food, 2nd edn. CRC Press, Boca Raton, FL, USA.
2. Berg, J.M., Tymoczko, J.L., Stryer, L. and Gatto Jr., G.J. 2002. Biochemistry, 7th edn. W.H. Freeman and Company, NY, USA.
3. Buchanan, B.B., Gruissem W. and Jones, R.L. 2002. Biochemistry and Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.
4. Moe, G., Kelley, D., Berning, J. and Byrd-Bredbenner, C. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
5. Nelson, D.L. and Cox, M.M. 2012. Lehninger Principles of Biochemistry, 6th edn. Macmillan Learning, NY, USA.
6. Voet, D. and Voet, J.G. 2011. Biochemistry, 4th edn. John Wiley and Sons, Inc., NY, USA.

Processing Technology of Cereals 3 (2+1)

Objectives

1. Learn milling technology of rice, wheat, corn and barley
2. Get knowledge about breakfast cereals and their processing

Theory

Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets Chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling; Milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Ageing of rice; Enrichment of rice – methods of enrichment; Rice fortification; Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions

and modified starches; Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

Practical

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value added products from millets; Visit to Cereal processing unit.

Suggested Readings

1. Araullo, E.V., De Padua, D.B. and Graham, M. 1976. Rice Post Harvest Technology. IDRC, Canada.
2. Chakraverty, A. and Singh, R.P. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
3. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
4. Champagne, E.T. 2004. Rice: Chemistry and Technology, 3rd edn. AACC International, Inc., St. Paul, MN, USA.
5. David, A.V. Dendy and Dobraszczyk, B.J. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
6. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
7. Khan, K. and Shewry, P.R. 2009. Wheat: Chemistry and Technology, 4th edn. AACC International, Inc., St. Paul, MN, USA.
8. Matz, S.A. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
9. Wrigley, C. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.
10. White, P. J. and Johnson. L. Lawrence A. 2003. Corn: Chemistry and Technology, 2nd edn. AACC International, Inc., St. Paul, MN, USA.

Processing Technology of Fruits and Vegetables 3 (2+1)

Objectives

1. Understand methods of preservation of fruits and vegetables
2. Get knowledge of FSSAI specifications of fruits and vegetables products

Theory

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of

fruits and vegetables; Supply chain of fresh fruits and vegetables; Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching- operations and equipment; Canning: - Definition, processing steps, and equipment.

Cans and containers, quality assurance and defects in canned products; FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products; FSSAI specifications of crystallized fruits and preserves, jam, jelly and marmalades, candies; Preparation, preservation and machines for manufacture of above products; Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, leather, dehydrated, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products; By-products of fruit and vegetable processing industry.

Practical

Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash; Preparation of syrup; Preparation of raisins, dried fig and dried banana; Preparation of anardana; Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.

Suggested Readings

1. Chavan, U.D. and Patil, J.V. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. Chakraverty, A. Mujumdar, A.S. Vijaya Raghavan, G.S. and Ramaswamy, Hosahalli S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. Cruess, W.V. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.
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5. EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.
6. Hui, Y.H. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.
7. Hui, Y.H., Chazala, S., Graham, D.M., K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
8. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
9. Pandey, P.H. 1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.

10. Rajarathnam, S. and Ramteke, R.S. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.
11. Srivastava, R.P. and Kumar, S. 2002. Fruit and Vegetable Preservation: Principles and Practices, 3rd edn. International Book Distribution Co., Delhi.
12. Thompson, A.K. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd edn. Blackwell Publishing Ltd., Oxford, UK.

Food Packaging Technology and Equipment 2 (1+1)

Objectives

1. Understand concept of packaging, its type and properties of packaging materials
2. Gain knowledge about intelligent, smart and active packaging
3. Learn labelling requirement and regulations

Theory

Packaging situations in World and India; Need of packaging; Package requirements, package functions; Properties of different packaging materials; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminum/ tin/ SS) as package material-manufacture, advantages, disadvantages, Plastic as package material, classification of polymers, properties of each plastics, uses of each plastics; Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging; Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging; Edible packaging- Types and sources; Microwavable packaging - Types and applications. Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package. Packaging practices followed for fruits and vegetables and their products, packaging machines, Filling machines, vacuum packaging machines. Bottle fillers, fillers for dry mixers, ice-cream fillers, Form fill and seal (FFS) machines, vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system; Labelling requirements, methods of coding and regulation and standards of labelling of food packages.

Practical

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers; Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of laquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits

and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

Suggested Readings

1. Ahvennainen, R. 2003. Novel Food Packaging Techniques. CRC-Woodhead Publishing Ltd., Cambridge, England.
2. Coles, R., McDowell, B. and Kirwan, M.J. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK
3. Han, J. H. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
4. Han, J.H. 2005. Innovations in Food Packaging. Elsevier Science and Technology Books, UK.
5. Lee, D. S. 2008. Food Packaging Science and Technology. CRC Press, Boca Raton FL, USA.
6. Robertson, G. L. 2014. Food Packaging: Principles and Practice, 3rd edn. CRC Press, Boca Raton, FL, USA.
7. Robertson, G. L. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.

Processing of Spices and Plantation Crops 3 (2+1)

Objectives

1. Learn processing technology of different spices
2. Understand post-harvest technology of tea, coffee, cocoa etc.

Theory

Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition; Processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Equipment for cryogenic grinding; Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram; Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves; Post-harvest technology for Tea, coffee, cocoa, Vanilla and annatto processing; Post-harvest technology and processing of areca nut, cashew nut, oil palm, coconut. Flavours of minor spices; Flavour of major spices. Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices. Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization. Functional packaging of spices and spice products; By-products of plantation crops and spices.

Practical

Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil,

specific gravity, refractive index, acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.

Suggested Readings

1. Gupta, S. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
2. Hirasa, K. and Takemasa, M. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
3. Panda, H. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
4. Pruthi, J.S. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
5. Pruthi, J.S. 2001. Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.
6. Purseglave, J.W., Brown, E.G., Green, C.L. and Robins. Spices, Vol. I and II. SRJ Academic Press, New Delhi.
7. Shanmugavelu, K.G. Spices and Plantation Crops. Oxford and IBH Publishing Co., New Delhi.

Food Storage Engineering 2 (1+1)

Objectives

1. Understand storage structure for grains and other perishables
2. Learn the design of storage structure

Theory

Introduction: Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis.

Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control.

Storage structures: Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos.

Storage of grains: Respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation.

Aeration and stored grain management: Purposes of aeration, aeration theory, aeration system design, aeration system operation.

Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control.

Storage of perishables: Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage.

Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.

Practical

Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

Suggested Readings

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brooker, D.B., Bakker-Arkema, F.W. and Hall, C.W. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
3. Hall, C.W. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
4. Jayas, D.S., White N.D.G. and Muir, W.E. 1994. Stored Grain Ecosystems. Marcel Dekker, New York.
5. Kutz, M. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
6. Michael, A.M. and Ojha, T.P. 2004. Principal of Food Technology, Vol. I. Jain Brothers, New Delhi.
7. Newbaver, L.W. and Walker, H.B. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
8. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
9. Pandey, P.H. 1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.

Project Preparation and Management 2 (1+1)

Objectives

1. Understand concepts of project management
2. Develop knowledge to develop a project plan and its analysis

Theory

Project and project Management, Evolution of project management, Forms and environment of project management; Project life cycle; Project Identification, Screening, Project Appraisal, Project

Selection, Project Proposal and Project Scope; Project Planning; Work break down structure and Network Scheduling; Critical Path Method; Program Evaluation and Review Technique; Time-cost relationship in project; Resource Considerations in Projects, Resource Profiles and levelling, limited Resource Allocation; Project Implementation, Monitoring and Control: Project management Process and role of project manager, team building, Leadership in Projects, Organizational and behavioural issues in Project Management; Project Monitoring and Control; Project Completion and Review; Project Management - Recent trends and Future Directions. Computers in Project Management.

Practical

Brainstorming exercise to identify a set of projects and their evaluation; work break down structure for different projects; Network Scheduling and Drawing network charts for different projects; Formulation of CPM scheduling for a specific project; Formulation of PERT scheduling for a specific project; Reduction of Project Duration: Time/cost trade off; Resource Profiles and levelling; PERT/Cost Method, Earned value analysis.

Suggested Readings

1. Chandra, P. 1980. Projects- Preparation, Appraisal, Budgeting and Implementation. Tata McGraw-Hill Publication, New Delhi.
2. Chandra, P. 2014. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.
3. Gopalakrishnan, P. and Rama Moorthy, V.E. 2014. Textbook of Project Management. Laxmi Publications Pvt. Limited
4. Kerzner, H. 2006. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers and Distributors.
5. Nicholas, J.M. 2005. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
6. Panneerselvam, R. 2004. Operations Research, 2nd edn. International Book House, Mumbai.

Agricultural Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition

based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Semester VI

Food Additives and Preservatives 2 (1+1)

Objectives

1. Understand types of food additives and their mechanism
2. Differentiate between natural and synthetic additives

Theory

Introduction to Food additives; Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; flavours, emulsifiers, sweeteners; Food preservatives and their chemical action; Role and mode of action of Class I and Class II preservatives; chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic); Identification of food colour by TLC (organic and inorganic); Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in frozen fish; Role of leaving agent in baked food product; Preservation of coconut shreds using humectants.

Suggested Readings

1. Belitz, H.-D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg
2. Deshpande, S.S. 2002. Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Mahindru, S.N. 2008. Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

Sensory Evaluation of Food Products 2 (1+1)

Objectives

1. Understand basic concept of sensory evaluation
2. Gain knowledge about consumer study

Theory

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation;

Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests.

Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures, descriptive sensory analysis, contour method, other procedures; Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

Practical

Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo- trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

Suggested Readings

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
4. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker.
5. Lawless, H.T. and Heymann. H. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd edn. Springer, New York or Dordrecht Heidelberg, London.
6. Macrae, R., Robinson, R.K. and Sadler, M.J. 1994. Encyclopedia of Food Science and Technology and Nutrition. Vol. XI. Academic Press.

7. Moskowitz, H. R. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
8. Piggot, J.R. 1984. Sensory Evaluation of Foods. Elsevier Science and Technology.
9. Potter, N.N. and Hotchleiss, J.H. 1995. Food Science, 5th edn. CBS Publishers, Delhi.
10. Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
11. Stone, H. and Sidel, J.L. 1985. Sensory Evaluation Practices. Academic Press, London.

Processing Technology of Legumes and Oilseeds 3 (2+1)

Objectives

1. Understand the nutritional value and composition of legumes and oil seeds
2. Gain knowledge about milling of pulse and oil seeds

Theory

Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti- nutritional compounds; Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency; Factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines.

Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

Practical

Determination of physical properties of legumes and oil seeds; Determination of proximate composition of selected pulses and oilseeds; Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill; Study of mini oil mill; Preconditioning of pulses before of mini oil mill; Preconditioning of pulses before milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal; Processing of composite legume mix and preparation of value added products; Visit to commercial dhal mills and oil mills.

Suggested Readings

1. Chakraverty, A. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

2. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA
3. Gunstone, F.D. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
4. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
5. Shahidi, F. 2005. Bailey's Industrial Oil and Fat Products, 6th edn., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.

Food Refrigeration and Cold Chain 3 (2+1)

Objectives

1. Understand the concept of refrigeration system, refrigerant and their properties
2. Design of cold storage and air conditioning systems for food storage application

Theory

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; plug and chill type refrigeration based on chemicals. Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine; water/lithium bromide and ammonia/water absorption cooling. Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants-physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations. Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display. Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food. Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-

conditioning systems; humidifiers and dehumidifiers; Cooling/Refrigeration load calculations: Load sources, product cooling, conduction heat load, convection heat load, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.

Practical

Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods; Study of spray freezing process for foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice-cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of deep freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.

Suggested Readings

1. ASHARE Handbook, 2006: Refrigeration.
2. Arora, C.P. 2000. Refrigeration and Air Conditioning, 2nd edn. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
4. Stoecker, W.F. and Jones, J.W.1982. Refrigeration and Air Conditioning, 2nd edn. McGraw-Hill Book Co., New York, USA.
5. Whitman, W.C., Johnson, W.M., Tomczyk, J.A. and Silberstein, E. 2009. Refrigeration and Air Conditioning Technology, 6th edn. Delmar, Cengage Learning, NY, USA.

Processing of Meat, Fish and Poultry Products 3 (2+1)

Objectives

1. Understand types of meat and the unit operations in meat, fish and poultry processing
2. Gain knowledge about various methods of preservation of meat, fish, poultry and their products.

Theory

Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish. Structure and composition of muscle, types, classification and composition of fish, Pre-slaughter operations and slaughtering operations for animals and poultry. Dressing and evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat. Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for- meat, poultry and fish, Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Meat

quality parameters – color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation; Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products; Problems on mass balancing of ingredients in formulation of value added meat products; Abattoir design and layout; Preservation of fresh fish, characteristic of fresh fish and fermented and value added products of fish; Spoilage indices of fish and factors affecting the spoilage of fish; Eggs: Structure, composition, quality characteristics, defects and grading of egg processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties, Preparation protocols of indigenous products: Fish sauce and paste; By-products of meat, poultry, fish and eggs and their utilization; Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI/ Kosher/Halal, EU hygienic regulations and ISO 9000 standards.

Practical

Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals; Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration; Evaluation of quality and grading of eggs; Preservation of shell eggs; Preparation of value added poultry meat products; Value added egg products; Visit to abattoir. Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Visit to fish and prawn processing industry.

Suggested Readings

1. Berkel, B. M.-V., Boogaard, B.V.-D. and Heijnen, C. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen.
2. Borstorm, G. 1961. Fish as Food - Vol. I, II, III and IV. Academic Press, New York.
3. FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.
4. Hall, G.M. 1997. Fish Processing Technology, 2nd edn. Chapman and Hall, London, UK.
5. Kerry, J., Kerry, J. and Ledward, D. 2005. Meat Processing-Improving Quality. Woodhead Publishing Ltd., Cambridge, England.
6. Lawrie, R.A. 1985. Meat Science, 4th edn. Pergamon Press, Oxford, UK.
7. Nanda, Vikas 2014. Meat, Egg and Poultry Science and Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
8. Rautenstrauss, B.W. and Liehr, T. 2002. Fish Technology. Springer-Verlag, US.
9. Sen, D.P. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.

10. Sharma, B.D. and Sharma, K. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
11. Sharma, B.D. 2003. Modern Abattoir Practices and Animal Byproducts Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
12. Stadelman, W.J. and Cotterill, O.J. 1995. Egg Science and Technology, 4th edn. Food Products Press, NY, USA.
13. Swatland, H.J. 2004. Meat Cuts and Muscle Foods, 2nd edn. Nottingham Univ. Press, Nottingham.
14. Toldrá, F., Hui, Y. H., Astiasarán, I., Nip, W.-K., Sebranek, J.G, Silveira, E.-T.F., Stahnke, L.H., Talon, R. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
15. Varnam, A.H. and Sutherland, J.P. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman and Hall, London.

Processing Technology of Beverages 3 (2+1)

Objectives

1. Learn different about types of beverages
2. Various technologies involved in beverage processing
3. Gain knowledge about FSSAI specifications of beverages
4. Understand ingredients, manufacturing and packaging processes for beverages.

Theory

History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice-based beverages, synthetic beverages, still, carbonated; Low-calorie and dry beverages, isotonic and sports drinks. Dairy based beverages, Alcoholic beverages, fruit beverages, specialty beverages, Tea, coffee, cocoa, spices, plant extracts, etc. FSSAI specifications for beverages. Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water; Sweeteners, colorants, acidulants, Clouding and clarifying and flavouring agents for beverages, Carbon dioxide and carbonation. Quality tests and control in beverages, Miscellaneous beverages: Coconut water, sweet toddy, Sugar cane juice, coconut milk, flavoured syrups.

Practical

Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant.

Suggested Readings

1. Ashurst, P.R. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd edn. Blackwell Publishing Ltd., Oxford, UK.
2. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook

of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.

3. Eblinger, H.M. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim. Germany.
4. Hui, Y.H. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Joshi, V.K. and Pandey, A. 1999. Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology, Vol. II. Educational Publishers and Distributors, New Delhi.
6. Varnam, A.H. and Sutherland, J.P. 1994. Beverages: Technology, Chemistry and Microbiology. Chapman, London, UK.

Bakery, Confectionery and Snack Products 3 (2+1)

Objectives

1. Learn the processing and packaging and storage of bakery and confectionary products
2. Understand extrusion technology and its application in production of breakfast cereals and snacks

Theory

Bakery products- Types (leavened and unleavened), specifications, compositions and ingredients (flour, sugar, fat, shortening, leavening agent etc.); Formulations, processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), equipment, packaging, storage and quality testing of bakery products. Processing technology of bread, biscuits and cakes. Classification of biscuits and manufacturing process of crackers

Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations; Hard boiled candies, pan coating, toffees and caramels, chewing gum and sugar free confections; Processing of chocolate – types cocoa beans and processing, other ingredients, mixing refining, conching, storage and packaging. Processing, equipment, packaging, storage and quality testing of confectionery and chocolate products. Product quality characteristics; Defects, causes and corrective measures. Extrusion technology and applications in food processing; Snack foods: Types, specifications, compositions, ingredients, Formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings. Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients; Formulations, processing, equipment for breakfast cereals, macaroni and malts; Packaging, storage and quality testing for breakfast cereals, macaroni and malts. Cooked corn products – tortilla chips; Modified starches for snack foods; Oils and industrial frying. Preservatives used in Bakery, Confectionery and snack products preservation; Quality testing of Bakery, Confectionery and snack products.

Practical

Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items; preparation,

packaging and quality evaluation of selected chocolates; Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

Suggested Readings

1. Amendola, J. and Rees, N. 2003. Understanding Baking: The Art and Science of Baking. 3rd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
2. Corke, H., Leyn, I.D., Cross, N.A. Nip, W.K., and Hui, Y.H. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.
3. Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd edn. Woodhead Publishing Limited, Cambridge, England.
4. Grewling, P.P. 2013. Chocolates and Confections, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Hui, Y.H. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
6. Jackson, E.B. 1995. Sugar Confectionery Manufacture, 2nd edn. Springer-Verlag, US.
7. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
8. Kingslee, J. J. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
9. Matz, S.A. 1976. Snack Food Technology, 2nd edn. AVI Publishing Co., Inc., Westport, Connecticut, USA.
10. Minife, B.W. 1989. Chocolate, Cocoa, and Confectionary – Science and Technology, 3rd edn. Chapman and Hall, Inc., New York, USA.
11. Pyler, E.J. and Gorton, L.A. 2009. Baking Science and Technology, Vol. II: Formulation and Production, 4th edn. Sosland Publishing Company, Kansas City, MO, USA.
12. Pyler, E.J. and Gorton, L.A. 2008. Baking Science and Technology, Vol. I: Fundamentals and Ingredients, 4th edn. Sosland Publishing Company, Kansas City, MO, USA.

Processing Technology of Liquid Milk 2 (1+1)

Objectives

1. Understand different steps of milk processing
2. Gain knowledge about different types of milk and their process

Theory

Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavored milk. Effect of thermal treatment on milk constituents. Fermented milk, acidophilous milk, etc.; Effect of thermal treatment on milk constituents; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting

these changes and effects of these changes on the quality of finished products. Cream: definition, classification, manufacture of different types of cream, processing of cream; Adulterations in milk and its detection; Quality defects in milk - causes and prevention. Liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical

Platform tests of raw milk (clot on boiling (COB) test, alcohol test); Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk; Packaging of liquid milk; Preparation of curd and yogurt, Visit to chilling centre and dairy plant.

Suggested Readings

1. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
2. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).
5. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
6. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.

Semester VII

Food Process Equipment Design 3 (2+1)

Objectives

1. Learn design consideration for storage vessels, evaporators, crystallizers, separators etc.
2. Knowledge of safety aspects in equipment design

Theory

Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations. Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort.

Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator. Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation. Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. Design of freezing equipment: Design of ice-ream freezers and refrigerated display system. Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer. Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. Design of fermenters: Design of fermenter vessel, design problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

Practical

Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

Suggested Readings

1. Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
2. Bhattacharyya, B. C. 2008. Introduction to Chemical Equipment Design- Mechanical Aspect. CBS Publishers and Distributors, New Delhi.
3. Couper, J.R., Penney, W.R., Fair, J.R. and Walas, S.M. 2012 Chemical Process Equipment: Selection and Design. Elsevier Inc.
4. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
6. Richardson, J F. and Peacock, D.G. 1994. Coulson and Richardsons's Chemical Engineering, Vol. 3, Chemical and Biochemical Reactors and Process Control, 3rd edn. Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands.
7. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.
8. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
9. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
10. Stanbury, P.F. Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.

11. Valentas, K.J., Rotstein, E. and Singh, R.P. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

Processing Technology of Dairy Products 3 (2+1)

Objectives

1. Learn the processing of dairy products viz. cream, butter, ghee, ice-cream etc.
2. Gain knowledge of traditional dairy products and their processing

Theory

Cream: Basic aspect, Classification, manufacture of different types of cream, processing of cream; Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter- defects, causes and their prevention, packaging and storage; Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage. Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram, equipment, quality testing, defects causes and prevention, packaging and storage. Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk. Manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage. Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.

Practical

Preparation of butter/ table butter, Preparation of ghee, Preparation of paneer; Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts; Preparation of condensed milk; Preparation of spray dried milk powder; Preparation of selected Indian dairy products; Shrikhand mawa/khoa based products halwa/ kheer etc., Determination of selected quality parameters of selected dairy products; Visit to dairy plant.

Suggested Readings

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. Technology of Indian Milk Products: Handbook of Process Technology Modernization for Professionals Entrepreneurs and Scientists, Dairy India Yearbook
2. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising, F.R. Germany.
5. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
6. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.

7. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.

ICT Applications in Food Industry 3 (1+2)

Objectives

1. Understand the requirement of information and its computerization and SCADA systems
2. Learn different software tools like MATLAB, GAMBIT, Fluent, LabVIEW etc.
3. Learn different techniques like Fuzzy logic, Neural network, Image processing etc.

Theory

Importance of computerization in food industry, operating environments and information systems for various types of food industries. Introduction to Supervisory control and data acquisition (SCADA): SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems. Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems. Use of add-ins, use of solver. Web hosting and webpage design; file transfer protocol (FTP), Online food process control from centralized server system in processing plant. Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system. Problem solving methodologies, numeric, cell, arrays, matrix operations; User defined functions, programming using MATLAB; debugging MATLAB programs, Applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB; Function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to Toolboxes useful to Food Industry, Curve fitting toolbox, Fuzzy logic toolbox, Neural Network toolbox, Image processing toolbox, statistical toolbox. Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry; Introduction to CFD softwares, GAMBIT and Fluent software, LabVIEW – LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW; LabVIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.

Practical

Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using

GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.

Suggested Readings

1. Bailey, D. and Wright, E. 2003. Practical SCADA for Industry. Elsevier, Burlington, MA
2. Chapman, N. and Chapman, J. 2006. Web Design: A Complete Introduction. John Wiley and Sons, USA.
3. Palm III, W.J. 2011. Introduction to MATLAB for Engineers, 3rd edn. McGraw-Hill Companies, Inc., NY, USA.
4. Sun, D.W. 2007. Computational Fluid Dynamics in Food Processing. CRC Press, Boca Raton, FL, USA.
5. Singh, R.P. 2014. Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis. Academic Press, London.

ELECTIVE COURSES

S. No.	Course Title	Credit hours
1.	Design and Formulation of Foods	3 (2+1)
2.	Industrial Microbiology	3 (2+1)
3.	Introduction to Food Biotechnology	3 (2+1)
4.	Business Management and Economics	2 (2+0)
5.	Statistical Methods and Numerical Analysis	2 (1+1)
6.	Instrumentation and Process Control in Food Industry	3 (1+2)
7.	Instrumental Techniques in Food Analysis	2 (1+1)
****8.**	Traditional Indian Dairy Products	2 (1+1)
****9.**	Ice-cream and Frozen Desserts	3 (2+1)
****10**	Energy Conservation and Management	2 (1+1)

** Sr No. 8-10 are cross-listed from Dairy Technology

Design and formulation of foods 3 (2+1)

Objectives

1. Understand about RDA for Indians
2. design and formulate new and innovative target foods
3. Gain knowledge about various therapeutic diets

Theory

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people. Production and formulation of Indian traditional sweet and snack food products,

steps for quality improvement and value addition. Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation. Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods. Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Suggested Readings

1. Antia, F.P. 1974. Clinical Dietetics and Nutrition, Oxford Medicine Publications.
2. Davidson, S., Passmore, R. and Eastwood, M.A. 1986. Davidson and Passmore Human Nutrition and Dietetics. Churchill Livingstone.
3. Gopalan, C., Ramshastri, B.V., Balasubramaniam, S.C. 1989. Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad.
4. Pokorny, J., Yanishlieva, N. and Gordon, M. 2001. Antioxidants in Food, Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science, 5th edn. Chapman and Hall, NY, USA.
6. Mazza, G.1998. Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson, C. 1975. Basic Nutrition and Diet Therapy, Macmillan.
8. Swaminathan, M.1974. Essentials of Nutrition, Ganesh Co.
9. Steinkrauss, K.H. 1995. Handbook of Indigenous Fermented Foods, Marcel Dekker.

Industrial Microbiology 3 (2+1)

Objectives

1. Learn about industrially important micro-organism and their growth
2. Understand bioreactor design and downstream processing

Theory

Overview of Industrial Microbiology; Introduction to industrial fermentations, Range of fermentation processes, Chronological development, Compartmental part of fermentation processes; Industrially Important Microorganisms. Criteria for Selection of Industrially Important Microorganisms, Overview of strain improvement of Industrially Important Microorganisms,

Preservation of industrially important microorganisms. Fermentation Media; Media selection, Medium Formulation, Medium for industrial fermentation; Microbial Growth; Typical Growth Curve, Synchronous growth, Batch Fermentations, Continuous Fermentation; Fed Batch Fermentation. Bioreactor Design: Basic functions, Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories, Types of reactor; Problems related to scale up of Process; Upstream and Down Stream Processes: Upstream processes, Overview of Downstream Processing, Methods of cell destruction, Methods of purification of enzyme/product, Concentration and Packaging.

Practical

Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/ proteases/Lipase; Production and assay of nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast Mushroom production.

Suggested Readings

1. Briggs, D.E., Boulton, C.A., Brookes, P.A. and Stevens, R. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
2. Casida Jr., L.E. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.
3. Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.
4. Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th edn. AVI Publishers, Connecticut, USA.
5. Stanbury, P.F., Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.

Introduction to Food Biotechnology 3 (2+1)

Objectives

1. Understand various biotechnological terminology
2. Understand application of biotechnology in food systems

Theory

Introduction, History and scope of biotechnology, Review of DNA replication, transcription, and translation. Review of DNA replication, transcription, and translation continued, Natural and artificial mechanisms of DNA transfer. Introduction to vectors, Selectable markers, Cloning vectors, Expression vectors, Shuttle vectors, Creation of recombinant DNA molecules, Creation of genomic and cDNA libraries. Library screening, Ligation, Restriction endonuclease digestion and mapping, Gel electrophoresis, Northern blotting, Southern blotting. Polymerase Chain Reaction (PCR), DNA sequencing and sequence analysis, Reverse transcriptase PCR, Real time PCR Week 8 Production of monoclonal antibodies, Immunoblotting. DNA microarrays, Protein microarrays. Introduction to

bioinformatics. Applications of biotechnology: Genetically engineered foods, Bioremediation, DNA fingerprinting, Molecular diagnostics, Molecular forensics Transgenic organisms, Ethical issues in biotechnology, The future of biotechnology.

Practical

Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization; Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*; Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by *Pseudomonas* spp.

Suggested Readings

1. Brandenberg, Oliver, Dhlamini, Zephaniah, Sensi, Alessandra, Ghosh, Kakoli and Sonnino, Andrea. 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.
2. Paul, Meenakshi. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
3. Primrose, S.B. and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.
4. Renneberg, R. and Lorch, V. 2017. Biotechnology for Beginners. Academic Press
5. Singh, B.D. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
6. Smith, J.E. 2009. Biotechnology, 5th edition, Cambridge University Press, Cambridge, UK
7. Stahl, U., Donalies, U.E.B. and Nevoigt, E. 2009. Food Biotechnology. Springer Berlin, Heidelberg.
8. Watson, James D. 2013. Molecular Biology of the Gene, 7th edn. Benjamin Cummings, San Francisco, USA.

Business Management and Economics 2 (2+0)

Objectives

1. Learn basic principles of management
2. Learn basic financial and human resource management

Theory

Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory. Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid. Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity; Markets: Types of markets and their characteristics. National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production; Law of variable proportions and law

of returns to scale. Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting. Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

Suggested Readings

1. Dewett, K.K. and Navalur, M.H. Modern Economic Theory. S. Chand and Sons, New Delhi.
2. Jain, S.P. Financial Accounting. Kalyani Publications, Ludhiana.
3. Harold, K. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
4. Prasad, L.M. 2001. Principles and Practices of Management, 9th edn. S. Chand and Sons, New Delhi.
5. Rao, P. Subba. Human Resource Management. Himalaya Publications.
6. Thomas, P.C. Managerial Economics, 9th edn. Kalyani Publishers.

Statistical Methods and Numerical Analysis 2 (1+1)

Objectives

1. Learn different statistical test
2. Understand design of experiments

Theory

Statistical inference and testing of hypothesis – Z test, t test and F test**,** Chi-square test and its uses – testing the goodness of fit and test of independence (contingency table)**,** Correlation and regression analysis**.** Basic principles of experimental design Analysis of variance (ANOVA) – one way and two-way classification. Basic designs- Layout and analysis of completely randomized design (CRD) with equal and unequal number of observations, randomized block design (RBD), Latin square design (LSD). Response surface methodology.

Practical

Problems on Z test – One and two sample test Problems on t test - One and two sample (dependent and independent) test; Problems on F test, chi square test, correlation and regression; Fitting of simple linear regressions; Fitting of multiple regression equations; ANOVA: One way/ two way; 2^2; Problems on CRD, RBD, LSD, Problems on response surface methodology.

Suggested Readings

1. Grewal, B.S. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
2. Gupta, P.P. and Malik, C.C.1993. Calculus of Finite Differences and Numerical Analysis. Krishna Prakash Mandir, Meerut.
3. Kreyszig, E. 2006. Advanced Engineering Mathematics, 9th edn. John Wiley and Sons, New York, USA.

Instrumentation and Process Control in Food Industry 3 (2+1)

Objectives

1. Learn different measurement and control parameters and instruments for their measurement
2. Understand process control in food processing

Theory

Introduction, definitions, characteristics of instruments, static and dynamic characteristics, Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure. Liquid level measurement, different methods of liquid level measurement, flow measurement, differential pressure meters, variable area meters; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale, Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples; Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware. Frequency response analysis, characteristics, Bode diagram and Nyquist plots and stability analysis; Controllers and indicators: Temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing; Introduction of 8051/8085 based system and applications in processing.

Practical

Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer; 8051 based programming examples; Programmable Logic Controllers (PLC) Hardware; PLC Ladder programming; control of Multiprocess system.

Suggested Readings

1. Bela G. Liptak. 2003. Instrument Engineer's Handbook, Vol. I and II, 4th edn. CRC Press, Boca Raton, FL, USA.
2. Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th edn. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Murty, D.V.S. 2004. Transducers and Instrumentation. Prentice Hall of India Pvt. Ltd. New Delhi.

Instrumental Techniques in Food Analysis 2 (1+1)

Objectives

1. Learn various instruments used for food analysis
2. Learn the methods of various analyses
3. Gain knowledge about various equipment and their working for those analyses

Theory

Concepts of food analysis; Rules and regulations of food analysis Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods, Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy, atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry.

Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultra centrifugation, iso-electric focusing, Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products; Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Quality evaluation of food products for color and taste of marketed products; Analysis of heavy metals using atomic absorption spectrophotometer; Estimation of physic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of pralines by ion- exchange chromatography; Molecular weight determination using sephadox-gel; Identification of organic acids by paper electrophoresis; Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE, GCMS; Quantitative make-up of water and fat soluble vitamins using HPLC; Fatty acid profiling using gas chromatograph; Separation of sugars by paper chromatography; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A and B).

Suggested Readings

1. Nieisen, S.S. 2010. Food Analysis Laboratory Manual, 2nd edn. Springer, NY, USA.
2. Nieisen, S.S. 2003. Food Analysis, 3rd edn. Kluwer Academic, New York, USA.
3. Ötles, S. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
4. Sun, D.W. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

**Traditional Indian Dairy Products 3 (2+1)

Objectives

1. Understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
2. Learn about the chemical composition and legal standards for traditional Indian sweets
3. Acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
4. Learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture. Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process. Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti Dahi: Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakand, Milkcake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, Misti Dahi, Chhana and Shrikhand; Visit to industry.

Suggested readings

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India
2. Agarwala, S.P. (2006). Equipment for paneer making, Lecture compendium on developments in traditional dairy products. Short course organized by CAS from Dec. 10-30, 2006: pp-132-137.
3. Dharam Pal and Narender Raju, P. (Eds). (2006). Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course, CAS in Dairy Technology, NDRI, Karnal.
4. Pal, D. (1997). Technology of the manufacture of rabri and basundi. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRl Deemed University, Karnal.

**Ice-Cream and Frozen Desserts 3 (2+1)

Objectives

1. Understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
2. Learn about design and working of Ice cream freezers including cleaning and sanitization
3. Aquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
4. Learn about the defects that appear in ice cream, causative factors and measures to control them

Theory

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts. Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant. Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention. Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Suggested readings

1. Arbuckle, W.S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut.
2. Hall, C.W. and Hedric, T.T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338.
3. Hui, Y.H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley – VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
5. NDRI. 1998. Advances in Ice Cream and Frozen Desserts. Lecture compendium, Sixth short course, Dec 15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.

7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.

8. Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th edn. Madison, Wisconsin, p 5-10.

**Energy Conservation and Management 2 (1+1)

Objective

- To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries

Theory

Introduction: Potential and Importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act 2003, Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy balances and computation of efficiencies of equipment; Role of Energy inspectors and Auditors in energy management; Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques; Quality of power, Power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motor-selection and application, Energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with Star Ratings of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls. Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors; Maintenance and upkeep of Vacuum lines and Compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment. Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator. Energy conservation in buildings: Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries; Role

of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of Energy Balance in Unit Operations and System boundaries; Solving examples on energy balances; Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve; Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different BEE Star Ratings; Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Suggested readings

1. Tufail Ahmand 2012 Dairy Plant Engineering and Management, Kitab Mahal Publisher.
2. JiřiKlemeš, Robin Smith and Jin-Kuk Kim 2008 Handbook of Water and Energy Management in Food Processing, A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.
3. Lijun Wang 2008 Energy Efficiency and Management in Food Processing Facilities, CRC Press Inc; 1st edition (4 December 2008); Taylor and Francis.
4. Paul O'Callaghan 1993 Energy Management, McGraw- Hill Book Company Europe, Shppenhangers Road, England.

Applications of Renewable Energy in Food Processing 2 (1+1)

Objective

To equip students with the knowledge about the alternative and renewable sources of energy available for operating of a food processing industry

Theory

Introduction to energy sources; classification of renewable energy sources, utilization of these sources in food processing sector; Solar radiation, measurement of solar radiation, types of solar collectors and their uses; familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; utilization of solar thermal energy in food processing; Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry; Biomass and its characterization; briquetting of biomass. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry and biodiesel preparation; Importance of biogas technology, production mechanism, types of biogas plants, uses of biogas, handling and utilization of digested slurry. Use of food waste for biogas generation and its applications; Brief introduction to wind energy, hydroelectric energy, ocean energy.

Practical

Study of solar radiation measuring instruments; Study of solar cooker; Study of solar water heater; Study of solar dryer; Study of solar PV system; Estimation of calorific value of biomass;

Estimation of moisture content of biomass; Estimation of ash content of biomass; Estimation of fixed carbon and volatile matter of biomass; Study of briquetting machine; Demonstration of up draft gasifier; Demonstration of down draft gasifier; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum type biogas plants; Demonstration of biodiesel preparation; Demonstration of wind measuring instruments.

Suggested Readings

1. Khandelwal, K.C. and S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
2. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
3. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
5. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
6. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.

Food Plant Design and Layout 3 (2+1)

Objective

To equip students to effectively design food processing plant incorporating the appropriate machinery, equipment, utility services, conforming to the legal standards.

Theory

Introduction Classification of food processing plants, food plant design concepts, situations giving rise to plant design problems and general design considerations (technical, economic, legal, safety and hygiene). Feasibility Study Steps involved in feasibility study, collection of the information, information flow diagrams, market analysis, technical analysis and preparation of feasibility report.

Plant Location Factors affecting plant location, their interaction with plant location, location theory models for evaluation of alternate locations. Plant Size Economic plant size, factors affecting the plant size (technical and economical), raw material availability, market demand, competition in the market, return on investment etc. Procedures for estimation of economic plant size (breakeven analysis and optimization), estimation of volume of production for each product.

Product and Process Design; Design of product, product specifications, least cost mix of raw materials, process design, process selection considering technical, economic and social aspects. Process planning and scheduling, flow sheeting, flow diagrams and process flow charts including their design and computer aided development of flow charts.

Selection of Equipment Process equipment, material handling equipment, service equipment, instruments and controls, considerations involved in equipment selection, economic analysis of equipment alternatives using optimization techniques and cash flows, economic decision on spare equipment, prediction of service life of the equipment.

Plant Layout Types of layouts, considerations involved in planning an efficient layout, preparation and development of layout, evaluation of alternate layouts, use of computers in

development and evaluation of layouts, equipment symbols, flow sheet symbols, electric symbols, graphic symbols for piping systems, standards for space requirement and dimensions, distances between critical plant areas and for different plant facilities.

Planning and Design of Service Facilities and Plant Surroundings Requirements of the steam, refrigeration, water, electricity, waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection etc. Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring. Planning of offices, laboratories, lockers and toilet facilities, canteen, parking lots and roads, loading docks, garage, repair and maintenance shop, ware houses etc.

Workers Safety and Health Aspects Falling hazards and safeguards, electric hazards, heat exposure, dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, personnel hygiene, sanitary requirements and standards, insect, rodent and bird control.

Building and Building Materials Requirements in respect of building type, wall, ceiling and floor construction, building height and building materials.

Practical

Prepare a feasibility report, prepare a plant location report, study design and layout of milk processing plant, study design and layout of fruit processing plant, To study design and layout of beverage plant, study design and layout of meat and meat products plant, To study design and layout of bakery and confectionery plant, study design and layout of grain processing plant, study design and layout of cold storage and warehouse, Design and layout of milk processing plant, Design and layout of fruit processing plant, Design and layout of beverage plant, Design and layout of meat and meat products plant, Design and layout of bakery and confectionery plant, Design and layout of grain processing plant, Design and layout of cold storages and warehouses.

Suggested Readings

1. Chemical Engineering Handbook by Perry R.H. Published by McGraw-Hill.
2. Chemical Engineering Plant Design by Villbrandt F.C. and Dryden C.E. Published by McGraw Hill.
3. Computer Aided Process Plant Design by Leesley M.E. Published by Gulf Publishing Company, Houston.
4. Engineering Economic Analysis by W.T. Morris. Published by Reston Publishing Company, Inc., New York.
5. Food Plant Economics by Z.B. Maroulis and G.D. Sarvacos. Published by CRC press.
6. Plant Design and Economics for Chemical Engineers by Peters M.S. and K.D. Timmerhaus. Published by McGraw-Hill.
7. Plant Layout and Design by J.M. Moore Published by The McMillan company.
8. Process Plant Design by Backhusrt J.R. and J.H. Barker. Published by Heimann Educational Books, London.
9. Project Feasibility Analysis by Clifton D.S. and D.E. Fyfee. Published by John Willey and Sons, New York.

10. Project Management for Engineers by M.D. Rosenau Published by Van Nostrand Reinhold Co., New York.

Waste and By-Products Utilization 3 (2+1)

Objectives

1. Understand the nature of agricultural wastes and their impact on the environment
2. Conceptualize physical, chemical and biological basis of agricultural waste treatment
3. Analyse and design systems for the collection, handling, treatment and utilization of wastes
4. Understand the waste treatment processes

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from food industry, rice mill, sugarcane industry, oil mill etc.

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues. Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; biofuels and ethanol, packaging material through recycling. Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting. Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal. Assessment, treatment and disposal of solid waste; Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water. Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash. Study about briquetting of agricultural residues. Estimation of excess air for better combustion of briquettes. Study of extraction of oil from rice bran. Study on bioconversion of agricultural wastes. Recovery of germ and germ oil from by-products of cereals. Visit to various industries using waste and food by-products.

Suggested Readings

1. Bhatia S C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.
2. Garg S K. 1998. *Environmental Engineering* (Vol. II) – *Sewage Disposal and Air Pollution Engineering*. Khanna Publishers, New Delhi

3. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment and Utilization Technology*. New India Publishing Agency.
4. Markel I A. 1981. *Managing Livestock Waste.* AVI Publishing Co.
5. Pantastico E C B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables.* AVI Pub. Co.
6. Prashar A and Bansal P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
7. Shewfelt R L and Prussi S E. 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc.
8. USDA 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
9. Weichmann J. 1987. *Post-Harvest Physiology of Vegetables*. Marcel and Dekker Verlag.
10. Vasso O and Winfried R (Eds). 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science and Business Media, LLC 233 New York.

SKILL ENHANCEMENT COURSES

1. Introduction to Drying Technology and Dryers
2. Introduction to Processing of Extruded Foods
3. Introduction to Milling (Rice, Dal, Spices, etc.)
4. Introduction to Electrical and Control Systems in Food Industry
5. Introduction to Mechanical Systems in Food Industry
6. Introduction to AutoCAD
7. Introduction to Food Safety and Sanitation
8. Introduction to Good Laboratory Practices
9. Basic Food Analysis Laboratory Techniques
10. Maintenance of Food Processing Equipment
11. Introduction to Bottling and Canning Line
12. Introduction to Manufacturing of Bakery Products

ONLINE COURSES

(6 credit hours)

Guidelines for taking the online courses

- The students will have to take a minimum of 6 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Food Technology) program.
- The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.
- The courses can be taken during the third year and 4th year of the UG program as per choice of students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

FORESTRY

Course Curricula for Undergraduate Program in UG- Certificate (Forestry) UG- Diploma (Forestry) B.Sc. (Hons.) (Forestry)

INTRODUCTION

Forests are an integral part of the society and played a significant role in socio-economic development of the country due to its role in providing wood and wood products. The forest management in India has witnessed a paradigm shift in management from production oriented to a conservation-oriented system. The growing population, industrialization, urbanization and the increasing interest in housing and energy sector have accelerated the demand for forest-based products. The production, protection, management and the associated service roles played by forests demand professional man power in order to manage the complex ecosystem sustainably. Considering this significance professional forestry education started in the country in 1985 and over three decades of forestry education has witnessed potential contribution by providing professional man powers to manage both natural and planted forests. However, with the changes in policy and legal issues coupled with the growing concerns and climate change, increasing demand for wood products have all necessitated transformation in forestry education towards meeting the changing demands for professionals.

Under such circumstances, the GoI through its National Education Policy -2020 has directed complete restructuring and revamping of curricula and syllabi as per the requirement of regional, national and global man power demand. The NEP has directed to ensure higher education for all sections of society at levels. The policy also advocated imparting skill and choice-based education to cater to the demands of graduating scholars. The policy envisaged light but tight academic frame work coupled with flexibility in education through multiple entry and exit activities. For this purpose, the policy directed to restructure and reframe completely the educational activities.

With this direction, the Indian council of Agricultural Research (ICAR) has mandated restructuring of syllabus and curricula in the entire courses falling under agriculture discipline. Against this back

drop, forestry syllabus has been restructured taking into consideration the directives from National Education Policy-2020 and the guidelines indicated by the Education Division of ICAR. Accordingly, the draft frame work of forestry syllabus has been conceived and the frame work has been discussed with almost all Forestry Colleges across India both through online and offline. Similarly, the syllabus has been presented to all levels of stakeholders like wood-based industries, farmers, NGOs, members of consortium of industrial agroforestry and agroforestry incubator. Besides, the framed syllabus has been presented to students and alumini of Forestry Colleges.

Based on these consultations and deliberations coupled with the directives from Deans' Committee, the syllabus has been redesigned and finally the frame work of syllabus has been designed and presented in this syllabus frame work. This syllabus has been conceived and designed in such a way that its satisfies the requirement of various nomenclatures of Forestry education like UG Certificate in forestry, UG Diploma in Forestry, UG Degree and UG Degree with Hons or research specialization program as per the provisions of NEP 2020. The syllabus has been framed in such a way that it will extend all entrepreneur skill and provides the students the required professional employment opportunities at all levels of entry and exit system.

In a holistic analysis and approach, the syllabus has been framed and presented to attract higher education in forestry sector towards managing and conserving the natural forests, extending technology based industrial plantations, create employment opportunities through skill-based courses and augment the ethics and value system in forestry education. I take this opportunity of thanking all stake holders for their suggestions and timely support in designing the Forestry Education curricula and syllabi as per the provisions of NEP 2020.

HIGHLIGHTS

- The forestry syllabus is restructured as per the direction of ICAR and also as per the needs and provision of NEP taking into consideration the current development in regional, national and global scenario.
- The 4-year under-graduate program in Forestry is designed with 167 core credits + 10 credits for MOOC course/ online courses preferred by the student as per his/ her choice.
- The course is designed judicially incorporating the fundamental and basic aspects of forestry coupled with management and technology orientation courses. Skill development courses are also incorporated at various levels along with Entry and Exit options to facilitate the students as per his/her/ze professional requirement.
- The skill development courses are incorporated in first two years (Semesters 1 to 4). Students have been given flexibility and choice in selection of skill development courses from a basket of multiple skill development modules offered in all the four semesters of first two years.
- Students will be given 4 credits of skill-based courses each in first and second semester, and 2 credits each in third and fourth semester respectively, so that he/she/ze will acquire enough knowledge and skill through hands-on training in related domain to get Certificate at the end of first year and Diploma at the end of second year, if he/she/ze opts to exit.

- After completing the courses of first year (Total 45 credits), if a student wishes to exit, he/she/ze will be eligible for award of UG-Certificate after completing an extra 10 weeks of internship (10 credits). The internship can be taken in form of Industry placement/ Industry exposure/ hands on training in related domain in the parent institute. The students continuing the study further, would not have to attend the internship after 1st year. Similarly, after completing the courses for first two years (total 85 credits) and 10 weeks' internship, the student becomes eligible for UG-Diploma on exit. The students continuing further for award of B.Sc. degrees need not take the internships after 1st and 2nd years.
- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given in proper amalgamation of theory and practicals to provide them hardcore knowledge of the Forestry discipline. In third year, the student will be taught intensive core courses of forestry to get the needed skill and expertise on the subject.
- In 4th year, the VII semester is designed exclusively for elective courses to inculcate the art of professional skill development of the graduating scholars. The elective courses are designed in such a way to develop skill on specific area of current forest development. Accordingly, four electives namely Plantation forestry, Multi-functional agroforestry, High yielding short rotation forestry and Forest product development and utilization have been designed and incorporated the new syllabus to cater to the needs of current regional, national and global development.
- In eighth semester of the degree program, the students will have to undergo Student READY Program to cover 20 credits. The Student READY Program may judicially incorporate internship attachment with wood-based industries/Forest department/Police/Special Task Force/Incubation centre/KVK/ Any research organization. Ideally it is recommended to have Internship with Forest Department (Administrative Skill) for 5 weeks, Internship with wood-based industries (Technical Skill) for 2 weeks, Internship with Police/ Special Task Force (STF) for Jungle survival for 1 week and Internship with incubation centres/KVKs for 2 weeks.
- The new courses like Trees outside Forests, Forest Biomass Energy and Biofuels, Arboriculture, Forest Landscape Restoration, Forest Business Management and Industrial Agroforestry are designed as per the requirement of current national and international development in forestry sector, which will create enough skill and expertise on the graduating scholars.
- 10 credits of non-credit courses are at the discretion of students. Students have the choice of MOOC to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these non-credit elective courses of 10 credits throughout the span of the degree program.

Entry and Exit Options

The entry and exit options for the UG programs in Forestry are shown in the Figure-1

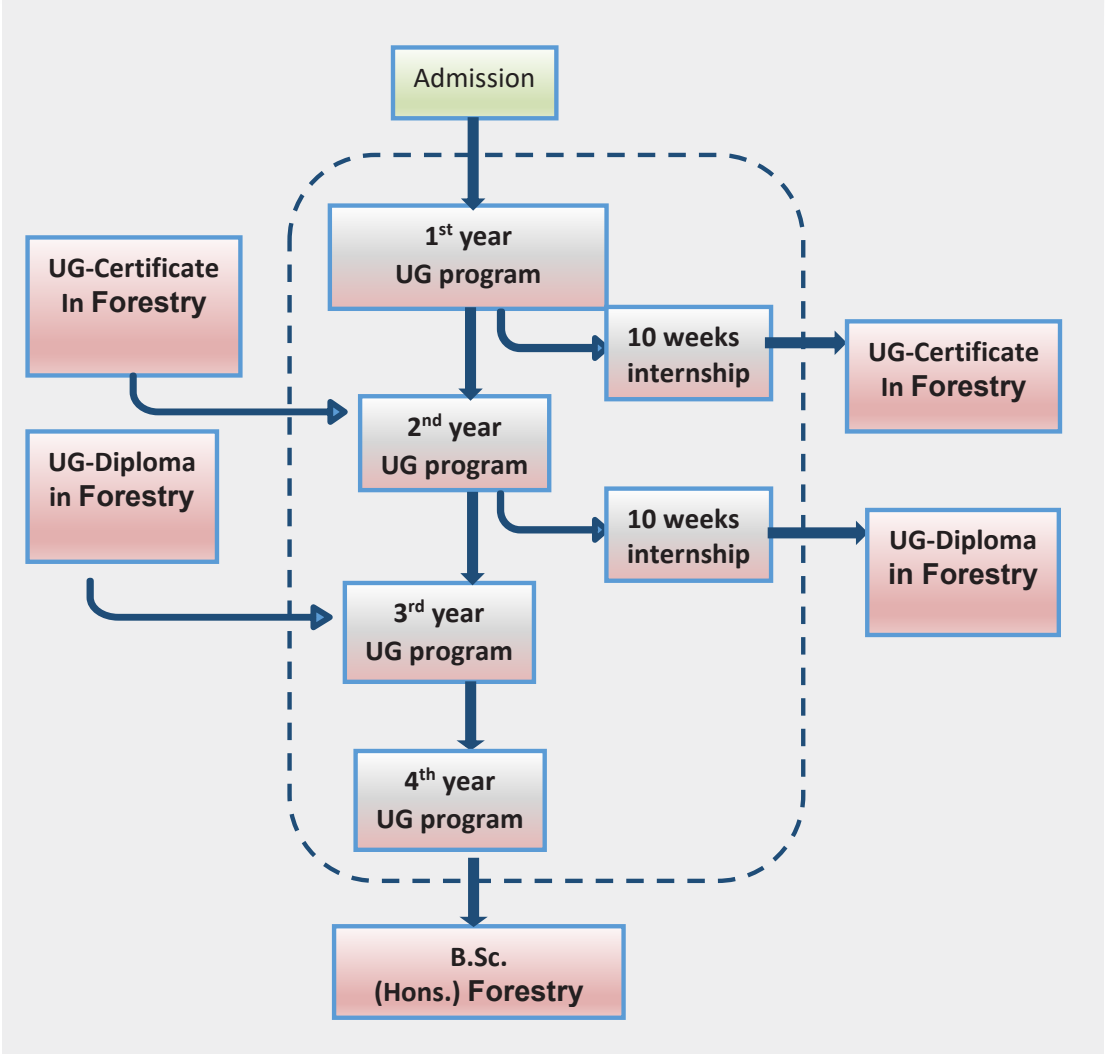

Fig.1 Entry and Exit options for the UG programs in Forestry

Exit options

UG-Certificate in Forestry (Exit after first year and completion of 10 weeks' internship)

UG-Diploma in Forestry (Exit after second year and completion of 10 weeks' internship)

B.Sc. (Hons.) Forestry (On successful completion of four-year degree requirements)

Admission Criteria

10+2 Intermediate with PCM/PCMB/Agriculture (P-Physics, C –Chemistry, M-Mathematics, Biology) from a recognized board/university.

ACADEMIC PROGRAM

Semester wise course distribution

S. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	Semester- I		
1.	*Deeksharambh* (Induction-cum-Foundation Program)	2 (0+2) (Non gradial)	**22 (11+11) (+2 NG)**
2.	Introduction to Forest Resources	3 (2+1)	
3.	Forest Plant Biology	3 (2+1)	
4.	Silviculture – Principles and Practices	3 (2+1)	
5.	Agroforestry Systems and Management	3 (2+1)	
6.	Skill Enhancement Courses (SEC-I)*	4 (0+4)	
7.	Farming Based Livelihood Systems	3 (2+1)	
8.	NCC-I/NSS-I	1 (0+1)	
9.	Communication Skills	2 (1+1)	
	Semester- II		
1.	Tree Seed and Nursery Technology	3 (1+2)	**23 (10+13)**
2.	Fundamental of Forest Genetics	2 (1+1)	
3.	Wood Anatomy and Identification	2 (1+1)	
4.	Forest Measurements and Inventory	3 (2+1)	
5.	Personality Development	2 (1+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Skill Enhancement Courses (SEC-II) **	4 (0+4)	
8.	NCC-II/NSS-II**	1 (0+1)	
9.	Entrepreneurship Development and Business Development	3 (2+1)	
	Post- II Semester Internship (Only for exit option for award of UG-Certificate)		
1.	Internship (10 weeks)	**10 (0+10)*** **	**10 (0+10)*** **
	Second Year		
	Semester III		
1.	Silviculture of Trees	2 (2+0)	**21(11+10)**
2.	Wood Science and Technology	2 (1+1)	
3.	Forest Microbiology	2 (1+1)	
4.	Forest Soil and Nutrient Management	2 (1+1)	
5.	Forest Survey and Engineering	2 (1+1)	
6.	Wildlife Sciences	3 (2+1)	
7.	Forest Health and Protection	2 (1+1)	
8.	Arboriculture	2 (1+1)	
9.	Physical Education, First Aid, Yoga practices and Meditation	2 (0+2)	
10.	Skill Enhancement Courses (SEC-III)****	2 (0+2)	

Semester IV			
1.	Commercial Forest Products and Utilization	3 (2+1)	**20(12+8)**
2.	Forest Ecology and Management	3 (2+1)	
3.	Tree Harvesting and Ergonomics	2 (1+1)	
4.	Forest Policy and Legislation	2 (2+0)	
5.	Statistical Methods	2 (1+1)	
6.	Agricultural Marketing and Trade	3 (2+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Skill Enhancement Courses (SEC-IV)*****	2 (0+2)	
Post- IV Semester Internship (Only for exit option for award of UG- Diploma)			
1.	Internship (10 weeks)	**10 (0+10)******	**10 (0+10)****
Third Year			
Semester V			
1.	Tree Physiology	2 (1+1)	**21(13+8) + 2 NG**
2.	Plantation Forestry	3 (2+1)	
3.	Tree Improvement	3 (2+1)	
4.	Forest Resource Management	2 (1+1)	
5.	Non-Timber Forest Products	3 (2+1)	
6.	Forest Pest and Diseases	3 (2+1)	
7.	Wildlife and Protected Area Management	3 (2+1)	
8.	Industrial Agroforestry	2 (1+1)	
9.	Study tour	2 (0+2) Non-Gradial	
Semester VI			
1.	Forest Biotechnology	3 (2+1)	**20 (13+7)**
2.	Forest Economics and Marketing	2 (1+1)	
3.	Watershed Planning and Management	2 (1+1)	
4.	Forest Tribology, Ethno-medicine and Extension	3 (2+1)	
5.	Remote Sensing and GIS	2 (1+1)	
6.	Forest Business Management	2 (1+1)	
7.	Forest Landscape Restoration (FLR)	2 (2+0)	
8.	Forest Biomass Energy and Biofuels	2 (1+1)	
9.	Trees Outside Forests	2 (2+0)	

Fourth Year			
Semester VII			
Elective Courses (Any of the following courses may be taken as electives)			
1	Plantation Forestry	20	**20**
2	Multifunctional Agroforestry	20	
3	High Yielding Short Rotation Forestry	20	
4	Forest Product Development and Utilization	20	
5	Forest Resource Management and Utilization	20	
Semester VIII			
1.	**Internship/ Project / Students READY Program**	**20**	**167 + 10******* (MOOC) + 4 (NG)**
	On-line courses (MOOC)	10	

*From the bouquet of available SEC-I modules
**From the bouquet of available SEC-II modules
*** Mandatory requirement for UG-Certificate. (On exit, the students will be eligible to be awarded UG-Certificate in Forestry)
****From the basket of available SEC-III modules (2 credits)
*****From the basket of available SEC-III modules (2 credits)
******Compulsory Internship for students exercising exit option (UG-Diploma) after IIndYear
*******On-line courses (MOOC); NG-Non Gradial

Department/ section wise course breakup

Sl. No.	Course Title	Credit hours	Total Credit Hours
A) CORE COURSES			
Silviculture and Agroforestry			
1	Silviculture – Principles and Practices	3 (2+1)	**17 (12+5)**
2	Silviculture of Trees	2 (2+0)	
3	Plantation Forestry	3 (2+1)	
4	Agroforestry Systems and Management	3 (2+1)	
5	Industrial Agroforestry	2 (1+1)	
6	Arboriculture	2 (1+1)	
7	Trees Outside Forests	2 (2+0)	
Forest Biology and Tree Improvement			
1	Forest Plant Biology	3 (2+1)	**16 (9+7)**
2	Tree Seed and Nursery Technology	3 (1+2)	
3	Fundamental of Forest Genetics	2 (1+1)	
4	Tree Improvement	3 (2+1)	
5	Forest Biotechnology	3 (2+1)	
6	Tree Physiology	2 (1+1)	

Sl. No.	Course Title	Credit hours	Total Credit Hours
Forest Products and Utilization			
1	Wood Anatomy and Identification	2 (1+1)	**15 (9+6)**
2	Wood Science and Technology	2 (1+1)	
3	Commercial Forest Products and Utilization	3 (2+1)	
4	Tree Harvesting and Ergonomics	2 (1+1)	
5	Non-Timber Forest Products	3 (2+1)	
6	Forest Biomass Energy and Biofuels	3 (2+1)	
Wildlife Sciences			
1	Wildlife Sciences	3 (2+1)	**6 (4+2)**
2	Wildlife and Protected Area Management	3 (2+1)	
Forest Resource Management			
1	Introduction to Forest Resources	3 (2+1)	**40 (24+16)**
2	Forest Measurements and Inventory	3 (2+1)	
3	Forest Ecology and Management	3 (2+1)	
4	Forest Health and Protection	2 (1+1)	
5	Forest Resource Management	2 (1+1)	
6	Forest Tribology, Ethno-medicine and Extension	3 (2+1)	
7	Forest Landscape Restoration (FLR)	2 (2+0)	
8	Forest Policy and Legislation	2 (2+0)	
9	Forest Soil and Nutrient Management	2 (1+1)	
10	Forest Economics and Marketing	2 (1+1)	
11	Forest Business Management	2 (1+1)	
12	Remote Sensing and GIS	2 (1+1)	
13	Forest Microbiology	2 (1+1)	
14	Forest Survey and Engineering	2 (1+1)	
15	Forest Pest and Diseases	3 (2+1)	
16	Watershed Planning and Management	2 (1+1)	
17	Statistical Methods	2 (1+1)	
ELECTIVE COURSES			
i) Plantation Forestry			**Student can take 20 credits from any one elective**
1	Commercial tree seedling production	3 (1+2)	
2	Commercial plantation development and management	3 (2+1)	
3	Forest growth modelling	2 (1+1)	
4	Marketing and certification of wood products	2 (1+1)	
5	Restoration of degraded lands	3 (2+1)	
6	Dendro-biomass and energy plantation	3 (2+1)	
7	Plantation and climate change mitigation	3 (2+0)	

Sl. No.	Course Title	Credit hours	Total Credit Hours
8	Plant Biochemistry	2 (1+1)	
9	Research Methodology	2 (1+1)	
10	Statistical Packages for Data Analysis	1 (0+1)	
11	Internship with forest plantations-based institutions/plantation companies	2 (0+2)	
ii) Multi-Functional Agroforestry			
1	Agroforestry system	3 (2+1)	
2	Interactions in Agroforestry Systems	2 (1+1)	
3	Agroforestry and Climate Change Mitigation	2 (2+0)	
4	Industrial agroforestry	3 (2+1)	
5	Ecotourism	3 (2+1)	
6	Dendro-biomass and energy plantation	3 (2+1)	
7	Introduction to Agronomy and Crop Production Technology	3 (2+1)	
8	Plant Biochemistry	2 (1+1)	
9	Research Methodology	2 (1+1)	
10	Statistical Packages for Data Analysis	1 (0+1)	
11	Agroforestry business incubation	2 (1+1)	
12	Internship with agroforestry-based institutions/industries	2 (0+2)	
iii) High Yielding Short Rotation (HYSR) forestry			
1	Applied Tree Improvement	3 (2+1)	
2	Reproduction biology of tree crops	3 (2+1)	
3	Biometrical genetics in tree breeding	2 (1+1)	
4	Marker assisted breeding in forestry	3 (2+1)	
5	Tissue culture application in forestry	3 (1+2)	
6	Controlled breeding in tree crops	2 (0+2)	
7	Tree seed orchards	3 (2+1)	
8	Forest genetic resources	2 (2+0)	
9	Clonal Forestry	2 (1+1)	
10	Plant Biochemistry	2 (1+1)	
11	Research Methodology	2 (1+1)	
12	Statistical Packages for Data Analysis	1 (0+1)	
13	Internship with tree breeding and biotechnology-based institutions/ industries	2 (0+2)	
iv) Wood and NWFPs Product Development and Utilization			
1	Wood identification	2 (0+2)	
2	Wood physics and chemistry	3 (2+1)	
3	Forest products laboratory techniques	2 (0+2)	

Sl. No.	Course Title	Credit hours	Total Credit Hours
4	Wood seasoning and preservation	3 (1+2)	
5	Wood working and carpentry	2 (0+2)	
6	Composite wood technology	3 (2+1)	
7	Non-wood forest products and value addition technology	3 (2+1)	
8	Ethnobotany, Medicinal and Aromatic plants	3 (2+1)	
9	Certification of Forest Products	2 (2+0)	
10	Plant Biochemistry	2 (1+1)	
10	Research Methodology	2 (1+1)	
11	Statistical Packages for Data Analysis	1 (0+1)	
12	Internship with forest products and technology-based institutions/ industries	2 (0+2)	
v) Forest Resources Management and Utilization			
1	RS and GIS Application for Forest Resource Management	3 (2+1)	
2	Ecosystem Services and Valuation of Forest Resources	3 (2+1)	
3	Entrepreneurship in value chain improvement of Forest Resources	3 (2+1)	
4	Joint Forest Planning and Management	2 (1+1)	
5	Climate Change Mitigation	3 (2+1)	
6	Ecotourism	3 (2+1)	
7	Restoration of Degraded Lands	3 (2+1)	
8	Urban Ecology and Environment	3 (2+1)	
9	Plant Biochemistry	2 (1+1)	
10	Research Methodology	2 (1+1)	
11	Statistical Packages for Data Analysis	1 (0+1)	
12	Internship with Forest Business Unit/RS-GIS Company or Organization	2 (0+2)	
B) MULTI-DISCIPLINARY COURSES			
1	Farming based livelihood systems	3 (2+1)	**9 (6+3)**
2	Entrepreneurship Development and Business Management	3 (2+1)	
3	Agriculture Marketing and Trade	3 (2+1)	
C) VALUE ADDED COURSES			
1	Environmental studies and Disaster Management	3 (2+1)	**6 (4+2)**
2	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
D) ABILITY ENHANCEMENT COURSE			
1	National Cadet Corps (NCC)/National Services Scheme (NSS)	2 (0+2)	**8 (3+5)**
2	Communication Skills	2 (1+1)	
3	Personality Development	2 (1+1)	
4	Physical Education, First Aid and Yoga practices	2 (1+1)	

Sl. No.	Course Title	Credit hours	Total Credit Hours
E) FORESTRY – SKILL ENHANCEMENT COURSES (SEC)			
1	Skill Enhancement Courses (SEC-I)	4 (0+4)	**12 (0+12)**
2	Skill Enhancement Courses (SEC-II)	4 (0+4)	
3	Skill Enhancement Courses (SEC-III)	2 (0+2)	
4	Skill Enhancement Courses (SEC-IV)	2 (0+2)	
F) Internship/ Project / Students READY Program			
1	Internship/ Project / Students READY Program	20 (0+20)	**20**
G) NON-GRADIAL			
1	Deeksharambh (Induction-cum-Foundation Program)	2	**4(NG)**
2	Study Tour	2 (0+2)	
H) MOOC Curses			
1	Online Courses	10	**10**

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major and minor/s)	:	112
Skill Enhancement Courses (SEC)	:	12
Common courses (MDC+VAC+AEC)	:	23
Internship / Student READY	:	20
**MOOCS/ Online Courses	:	10 (Non-gradial)
Grand Total		**167+10****

Table 1: Summary of credit hours for different categories of courses (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3[2]		1[3] + 2[4]	4	-	22	2[1]		
II	10	3[5]	3[6]	1[3] + 2[7]	4	-	23	-	10[12]	
III	17	----		2[8]	2	-	21			
IV	12	3[9]	3 [10]	----	2	-	20	-	10[13]	**10**
V	21	-	-	-	-	-	21	2[11]		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

Note: The credit hours mentioned in the table includes both theory and practical.

1. *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
2. Farming based Livelihood systems
3. NCC/NSS/NSO
4. Communication Skills
5. Entrepreneurship Development and Business Management
6. Environmental Studies and Disaster Management
7. Personality Development
8. Physical Education, First Aid, Yoga Practices and Meditation.
9. Agriculture Marketing and Trade
10. Agriculture Informatics and Artificial Intelligence
11. Study tour (10-14 days)
12. Only for those opting for an exit with UG-Certificate
13. Only for those opting for an exit with UG-Diplom

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Program) 0+2 (NG)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

- Help for cultural integration of students from different backgrounds
- Know about the operational framework of academic process in university
- Instilling life and social skills
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

I. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
II. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
III. Group activities to identify the strength and weakness of students (With expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
IV. Activities to enhance cultural Integration of students from different backgrounds.
V. Field visits to related fields/ establishments
VI. Sessions on personality development (Instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Introduction to Forest Resources 3 (2+1)

Objective

- To impart knowledge about the basic concepts of Forestry and familiarize the students about developments in the field of forestry.

Theory

Forests; definitions, role, benefits; direct and indirect. History of Forestry- Forestry- definitions, divisions and interrelationships. Classification of forests- Forest types. Agricultural lands and forests- Agroforestry systems; differences in nutrient cycling, diversity etc. Social forestry, joint forest management; programs and objectives. Important acts and policies related to Indian forests. Global warming; forestry options for mitigation and adaptation- carbon sequestration. Introduction to world forests- Geographical distribution of forests and their classification- Factors influencing world distribution of forests- productivity potential and increment of world forests. Forest resources and forestry practices in different regions of the world; Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan, and China. General problems of forest development and

economy. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry. Important events/dates related to forests and environment - Themes and philosophy.

Practical

Identification of important farm grown trees. Identification of tree seeds and seedlings. Visit to various forest types, viz., thorn forest, dry deciduous forests, moist deciduous forests, Shola grass land ecosystem, semi evergreen forests and wet evergreen forests to study the factors of locality and species composition. Visit to different forest plantations, Agroforestry plantations and other woodlots. Identification of wood and non- wood forest products. Visit to forest-based institutes and industries.

Suggested Readings

1. Beazley, M. 1981. The International Book of Forest. London
2. Champion and Seth. 1968. Forest types of India.
3. Grebner, D.L., Bettinger, P. and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
4. Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi.
5. Mather, A.S. 1990. Global forest resources. Belhaven, London
6. Mitchell Beazly.1981. The International Book of the Forest. Mitchell Beazly Publishers, London.
7. Parthiban, K.T, N. Krishnakumar, B. Palanikumaran, R. Thirunirai Selvan and N. Kanagaraj. 2022. FAQ'S on Forestry for IFS Aspirants. Scientific Publishers, Jodhpur (ISBN No.: 9789392590061)
8. Parthiban, K.T, N. Krishnakumar and M. Karthick. 2018, Introduction to Forestry, Scientific Publisher, Jodhpur. 350p
9. Persson, R. 1992. World forest resources. Periodical experts, New Delhi.
10. Westoby, J. 1991. Introduction to World Forestry. Wiley, 240p.

Forest Plant Biology 3 (2+1)

Objective

- To inculcate the fundamentals of botany and taxonomy of gymnosperms and angiosperms

Theory

Plant classification and systematic. Botanical Nomenclature – ICBN (International code of Botanical Nomenclature) - Rules and Codes of ICBN, Binomial and Polynomials. Systems of classification - Natural, Artificial and Phylogenetic classification. Principles of systematics. Demerits and merits of plant classification as given by Engler and Prantl, Hutchinson, Bentham and Hooker, Angiosperm Phylogenic Group (APG) and Other modern classifications. Morphology as a tool for tree identification - Field characters - Branching pattern, Leaf, Fruit and Bark. Role of reproductive characters - Flower types, floral formulas and floral diagrams. Reproductive morphology of plants with reference to description and identification of reproductive parts - General form of woody

trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of bark of common Indian trees - Types of exfoliation patterns in bark. Methods of Floristic survey and need for botanical explorations. Herbarium techniques -Collection, processing and preservation of plant material. General study of herbarium, arboretum, Palmetum, Fruticetum, Bambusetum and Xylarium. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora of families of Gymnosperms viz., Pinaceae, Taxaceae, Coniferae. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora for the families of Angiosperms viz., Annonaceae, Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Fabaceae, Meliaceae, Salicaceae, Lauraceae, Apocynaceae and Betulaceae. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora for the families of Angiosperms viz., Fagaceae, Moraceae, Tiliaceae, Euphorbiaceae, Dipterocarpaceae, Bixaceae, Cupressaceae, Guttiferae (Clusiaceae), Myrtaceae, Rubiaceae, Sterculiaceae, Bignoniaceae and Combretaceae.

Practical

Morphological description of plant parts with special reference to identification. Study on types of leaves, phyllotaxy and venation, Inflorescence, Bark with suitable examples. Methods of plant collections and herbarium preparation. Laboratory and field identification of important forestry species using vegetative and reproductive characteristics of Magnoliaceae, Ebenaceae, Fabaceae, Meliaceae, Salicaceae, Tiliaceae, Taxaceae, Pinaceae, Myrtaceae, Rubiaceae, Sterculiaceae, Bignoniaceae and Combretaceae. Visit to Botanical Garden and Arboretum for identification of trees.

Suggested Readings

1. Bhatnagar, S.P. and Alok Moitra. (2000). Gymnosperms. New age International (P) Ltd.
2. Bor, N. L. (1990). Manual of Indian Forest Botany. Periodical Expert Book Agency. New Delhi.
3. Brandis. Revised by R. D. Jakarti. (2010). Indian Trees. Dehradun.
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5. Dasgupta, S. (1998). Systematic Botany for Foresters. Khana Bandhu Publ., New Delhi, India.
6. Datta, S.C. (1999). Systematic Botany. New Age International (p) Ltd. Publ. New Delhi, India.
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9. Krishnen, Pradip. (2013). Jungle Trees of Central India. Published by Penguin Books India Pvt. Ltd. New Delhi.
10. Kumar, Ashok. (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
11. Mishra, S. R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd. New Delhi.

12. Mishra, S.R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd.
13. Naqshi, R. (1993). An Introduction to Botanical Nomenclature. Scientific Publishers. Jodhpur.
14. Pandey, S. N. and Mishra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
15. Parker, R. N. (1933). Forty Common Indian Trees and How to know them. (Available online PDF)
16. Randhawa, M. S. (1957). Flowering Trees in India. Sree Saraswati Press Ltd. Kolkata.
17. Sahni, K. C. (2000). The Book of Indian Trees. Bombay Natural History Society. Mumbai.
18. Santapau, Father H. (1966). Common Trees. (Available online PDF)
19. Singh, Gurucharan. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
20. Tewari, N. (1992). Tropical Forestry in India. International Book Distributors, Dehradun.

Silviculture – Principles and Practices 3 (2+1)

Objectives

1. To develop basic understanding on forest and factors influencing forest growth and development
2. To develop skill for the artificial and natural regeneration of forest
3. Exposing students to develop skill on raising and maintaining plantation
4. To impart knowledge on tending operations followed in forest with preliminary information on succession in forest

Theory

Definition and classification of Forest and Forestry - Branches of forestry and their relationships - Trees and their distinguishing features. Forest Reproduction - Flowering, fruiting and seeding behaviour. Site factors - Climatic, edaphic, physiographic, biotic and their interactions. Classification of Climatic Factors - Role of light, temperature, rainfall, snow, wind, humidity and evapotranspiration in relation to forest vegetation. Bioclimatic and Micro climate effects. Edaphic factors - Influence of biological agencies, parent rock, topography on the soil formation - Soil profile - Physical and chemical properties, mineral nutrient. Physiographic factors - influence of altitude, latitude, aspect and slope on vegetation. Biotic factors - Influence of plants, insects, wild animals, man and domestic animals on vegetation. Forest types of India - Basis and systems of classification - Major groups - Revised classification of forest types of India - Tropical, Montane sub-tropical, Montane temperate, Subalpine and Alpine - Sub groups - Types - Species composition and distribution. Forest types of Tamil Nadu. Regeneration of forests - Objectives, ecology of regeneration - Natural and Artificial regeneration. Natural regeneration - Seed production, seed dispersal, germination and establishment. Requirement for natural regeneration. Dieback in seedling with examples. Advance growth, coppice - Root sucker. Regeneration survey - Natural regeneration supplemented by artificial regeneration. Artificial regeneration - Object of artificial regeneration - Advantages. Factors governing the choice of regeneration techniques. Choice of species and factors that govern. Sowing v/s planting - Preparation of planting material - Field planting and techniques - Plant protection and sanitation measures - Forest nutrition and irrigation in trees.

Practical

Study about habits of plants and developmental stages of tree growth and its structure. Study about tree morphology - Stem, crown and root characters. Assessment of forest composition. Study about stand structure. Assessment of natural regeneration. Planting pattern and planting technique for afforestation and reforestation. Exercise on Seed and nursery practices. Planting pattern and planting technique for afforestation and reforestation. Field preparation, marking, alignment and stacking, pit making and planting. Plant protection and sanitation measures. Study of afforestation and reforestation success.

Suggested Readings

1. Champion, H.G. and S.K. Seth. 1968. A revised survey of the forest types of India. Manager of Publication, Delhi.
2. David M. Smith. 1989. The Practice of Silviculture. EBD Educational Pvt. Ltd., Dehradun. P.526
3. Dwivedi, A. P. 2006. A Text book of Silviculture. International Book Distributors, Dehra Dun. 505 p.
4. Haig, I.T., M.A. Huberman and U. Aung Din. 1986. Tropical Silviculture. Periodical Experts Book Agency, New Delhi. Vol. 1, p. 190.
5. Khanna, L.S. 2000. Principles and practice of Silviculture. Milton Book Company, Dehra Dun. 473
6. Luna, R. K. 1989. Plantation forestry in India. International Book Distributors, Dehra Dun. P. 476
7. Parthiban, K.T, R.J. Sudhagar, S. Umesh Kanna, S. Vennila, I. Sekar and K. Baranidharan. 2016. Forestry: A Subjective Guide for IFS Aspirants. Scientific Publishers - Competition Tutor, Jodhpur (ISBN No.: 9789386102096)

Agroforestry Systems and Management 3 (2+1)

Objectives

1. To develop basic understanding on agroforestry in different agro-climatic zones.
2. To develop skill on various agroforestry systems and carbon sequestration in agroforestry systems.
3. Exposing students to develop skill on Industrial Agroforestry

Theory

Agroforestry systems in different agro climatic zones – Tropical agroforestry, temperate agroforestry, arid and semi-arid agroforestry and humid agroforestry - components, production and management techniques. Alley cropping- functional and structural attributes of alley cropping, soil management, choice of species - productivity of various Agroforestry systems. High-density short rotation plantation systems – choice of species, design, development and management - Silvicultural woodlots/energy plantations - choice of species, design, development and management. Different types of agroforestry systems – silvi-agriculture - shelterbelts and windbreaks - design, aerodynamics and management - silvopastoral systems - live fences; fodder trees and protein banks and Agri-silvopastoral systems – home gardens, hedge rows, Multistorey system and their mangement; Special

systems - Apisilviculture, silvisericulture, aquaforestry etc. Agroforestry for wasteland development. Canopy management - Lopping, pruning, pollarding, and hedging. Diagnosis and design methods and approaches. Biophysical and ecological functions of agroforestry: Nutrient cycling and role of agroforestry in soil and water conservation - micro-site enrichment by trees, N fixation, improvement in soil physico-chemical properties and soil organic matter status, litter and fine root dynamics, nutrient pumping; beneficial effects of species mixture - rhizosphere and phillosphere effects. Carbon Sequestration-Climate change mitigation and phytoremediation. Adverse effects of trees on soils - competition, allelopathy – Causes and mechanisms. Industrial Agroforestry – scope and potential in India – major wood based industries - People's participation, rural entrepreneurship through Agroforestry and industrial linkages – contract farming – types and systems – successful contract farming models – timber transit rules for farm grown trees - Financial and socio-economic analysis of Agroforestry systems. Evaluation of tangible and intangible benefits – Agroforestry research and development in India - National Agroforestry Policy 2014 – objectives and strategies.

Practical

Study characteristics of trees/shrubs/grasses for agroforestry – Designing and development of multifunctional agroforestry model - Survey agroforestry practices in local/ adjoining areas - Visit to prominent agroforestry systems, other plantation crop combinations, Homegardens, other integrated multitier agroforestry systems and study their structural and functional attributes- Establishment and management of fodder bank – Studies on Integrated Farming System - Establishment and assessment of Industrial agroforestry plantations - Volume and biomass estimation- Carbon sequestration assessment- Crown measurement, light interception, leaf area index measurements in agroforestry systems. Annual crops/grass growth measurements and yield estimation – Determination of cost and returns of various agroforestry systems.

Suggested Readings

1. Chundawat D.S. and S. K. Gautham. 2017. Textbook of Agroforestry. Oxford and IBH Publishing, (ISBN: 9788120408326)
2. Divya M. P. and K. T. Parthiban. 2005. A Textbook on Social Forestry and Agroforestry. Satish Serial Publishing, New Delhi (ISBN: 9384988952).
3. Nair P. K. Ramachandran. 1993. An Introduction to Agroforestry. Springer Dordrecht (ISBN: 978-0-7923-2134-7)
4. Parthiban, K.T. and A. Keerthika. 2021. A Textbook of Agroforestry – Principles, Practices and Application. Agro Bios (India), Jodhpur. (ISBN: 9788197377689)
5. Parthiban, K.T. and R. Seenivasan. 2017. Plantation and Agroforestry: Pulpwood Value Chain Approach. Published by Scientific Publisher, Jodhpur. Pp: 517.
6. Parthiban, K.T., et al., 2018. Multifunctional Agroforestry – Ecosystem services. Narendra Publishers. New Delhi. Pp: 419.
7. Parthiban, K.T., R. Umarani, S. Umesh Kanna, I. Sekar, P. Rajendran, and P. Durairasu. 2014. Industrial Agroforestry Perspective and Prospectives. Scientific Publisher. Jodhpur. Pp.396.

Skill Enhancement Course (Indicative SEC- I Courses) 4 (0+4)

- Commercial Seedling Production
- Forest Machine Learning Technology

- Commercial Forestry
- Landscape Management and Restoration
- Wildlife Photography
- Ecotourism
- Para-taxonomy
- Ornithology
- Herpetology
- Design and development of wood products

Farming Based Livelihood Systems **3 (2+1)**

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (dairy, piggery, goatry, poultry, duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different Agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models),

Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar]
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

- To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

National Cadet Corps (NCC-I) 1 (0+1)

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilfull in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Tree Seed and Nursery Technology 3 (1+2)

Objectives

1. To impart knowledge on production, collection, processing, quality control and storage of tree seeds and its application in production and conservation of forests.

2. To impart knowledge on quality nursery stock and clonal technologies for production of quality planting stock in forest trees.

Theory

Introduction - Seed technology and its role in forestry - Seed quality. Seed biology - Seed structure, Fertilization and Seed development. Seed germination - Types and stages of seed germination - Factors affecting seed germination. Seed dormancy - Types - Causes - Merits and demerits. Production of quality seeds - Candidate tree, plus tree and elite tree. Seed production areas - Establishment and management of SPA. Seed orchards - Types of seed orchard - Establishment and management of seed orchards. Factors affecting tree seed production - Influence of provenance and seed source. Seed collection - Planning and organizing seed collection - Methods and factors affecting choice of seed collection. Seed extraction - Methods of extraction in different types of fruits. Seed treatment - Pre-sowing seed treatments - Priming - Pelleting - Dormancy breaking treatments - Pre-storage treatments. Seed storage - Orthodox and recalcitrant seeds - Natural longevity of tree seeds - Factors affecting longevity in storage - Storage conditions - Methods and containers. Seed testing. Classes of seeds - Seed quality control mechanism - Certification procedure- Classes of tree seeds - OECD procedure for tree seed certification - Plant quarantine - International organizations involved in seed quality control - Seed Legislation in India. Forest Nurseries - Types, selection of site, nursery layout and nursery area. Potting mediaseedbeds and containers (Poly bags and root trainers). Propagation - Types - Sexual and Asexual Propagation - Vegetative and Tissue Culture Techniques - Media and Potting Mixtures.

Practical

Tree Seed Technology: Identification and study on external and internal structure of tree seeds and physiological maturity tests. Visit to seed production area. Physical purity analysis, Determination of seed moisture, Seed germination test, Seed viability test, TTZ test, Hydrogen peroxide test, Seed vigour test, Conductivity test, Accelerated ageing test and Seed health testing. Tree Nursery Technology: Nursery technology for quality nursery stock production in small seeded species - Big seeded species - Recalcitrant seeds - Endangered tree species. Nursery techniques for large size seedlings for avenue planting and problem soils. Clonal forestry – Potting media – Plant growth substances – Propagation methods through cuttings, grafting, layering and budding.

Suggested Readings

1. Agrawal, R.L. 1986. Seed Technology. Oxford - IBH Publishing Co. New Delhi.
2. Bedell, P.E. 1998. Seed Science and Technology: Indian Forestry Species. Allied Publishers, New Delhi.
3. Bewely, J.D and Black, M. 1985. Seed- Physiology of development and germination.
4. Chin, H.F. and Roberts, E.H. 1980. Recalcitrant Crop Seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia.
5. Hannah Jaenicke. 2007. Good Tree Nursery Practices. International Centre for Research in Agro forestry, Kenya.
6. Hartmann, H.T and Kester, D.E. 1968. Plant propagation – principles and practice prentice – Hall of India Private Limited, New Delhi.
7. ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland.

8. Leadem, C.L. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.
9. Napier, I. and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu.
10. Ram Prakash. 2007. Plantation and nursery techniques of forest trees. International Book Distributers, Dehra Dun.
11. Ramamoorthy and K. Sivasubramanian. 2006. Seed Legislation in India. Agrobios, Jodhpur.
12. Renugadevi, J., P. Srimathi, P.R. Renganayaki and V. Manonmani. 20101. Seed Testing. Agrobios, Jodhpur.
13. Sharma R.R and Manish Srivastava. 2007. Plant propagation and nursery management. International Book Distributers, Dehra Dun.
14. Umarani, R. 2006. Tree Seed Technology. Scientific Publishers, New Delhi.

Fundamentals of Forest Genetics 2 (1+1)

Objective

- To understand the fundamental concepts of Genetics and Cytogenetics

Theory

Definition of genetics, heredity, inheritance, cytology, cytogenetics; Brief history of developments in genetics and cytogenetics. Physical basis of heredity. Structure and function of cell and cell organelles – Differences between Prokaryotes and Eukaryotes. Cell division – mitosis-meiosis and their significance - Gametogenesis and syngamy in Plants. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, heterochromatin, NOR, satellite chromosome, karyotype, ideogram. Types of chromosomes based on position of centromere, Chromosomal aberration: Variation in chromosome structure – deletion, duplication, inversion and translocation – genetic and cytological implications. Chromosomal aberration: Variation in chromosome number – euploid, aneuploid, types of aneuploids and their origin; Klinefelter syndrome and Turner syndrome; Polyploid - auto and allopolyploids, their characters; meaning of genome; evolution of wheat, triticale, cotton, tobacco, Brassica. Mendel's experiments and laws of inheritance. Rediscovery of Mendel's work. Terminologies: gene, allele, locus, homozygous, heterozygous, hemizygous, genotype, phenotype, monohybrid, dihybrid, trihybrid, polyhybrid. Allelic interactions – Dominance vs recessive, complete dominance, codominance, incomplete dominance, Non allelic interaction with modification in Mendelian ratio – (i) Dominant epistasis (12:3:1). (ii) Recessive epistasis (9:3:4). (iii) Duplicate and additive epistasis (9:6:1). (iv) Duplicate dominant epistasis (15:1). (v) Duplicate recessive epistasis (9:7). (vi) Dominant and recessive epistasis (13:3); Summary of epistatic ratios (i) to (vi). Lethal genes, Pleiotrophy, penetrance and expressivity, Multiple alleles, blood group in human, coat colour in rabbits, pseudo alleles, isoalleles. Polygenes – transgressive segregation, comparison of quantitatively and qualitatively inherited characters; modifiers; Linkage - coupling and repulsion; Crossing over – significance of crossing over; Factors controlling crossing over. Strength of linkage and recombination; Two point and three points test cross. Double cross over, interference and coincidence; genetic map, physical map.

Sex determination: Autosomes and sex chromosomes - chromosomal theory of sex determination different types –Sex determination in plants. Cytoplasmic inheritance and maternal effects – features of cytoplasmic inheritance, chloroplast, mitochondrial - plastid colour in *Mirabilis jalapa*

- cytoplasmic male sterility. Watson and Crick model. Models of DNA replication; steps involved in DNA replication. RNA types - mRNA, tRNA, rRNA. Protein synthesis, Mutation – characteristics of mutation – micro and macro mutation, Transition and transversion; major physical and chemical mutagens.

Practical

Study of microscopes – Preparation of fixatives and stains – Pretreatment of materials for mitosis and meiosis – study of mitosis and meiosis. Study of genetic ratios of – monohybrid, dihybrid – incomplete dominance. Gene interaction - multiple alleles and multiple factors. Study of linkage, Estimation of strength of linkage and recombination frequency in three points test cross data and F2 data – Drawing of genetic map – interference and coincidence. Studies on sex linked inheritance in Humans and Drosophila.

Suggested Readings

1. Benjamin Lewin. 2005. Genes IX Oxford University Press, Oxford.
2. Daniel Sundararaj, G. Thulasidas and M. Stephen Dorairaj, 1997. Introduction to Cytogenetics and Plant Breeding. Popular Book Depot, Chennai –15.
3. Gupta P.K., 1997. Cytogenetics. Rastogi Publications, Meerut.
4. Pundhansingh. 2014. Elements of Genetics. Kalyani Publishers.
5. Russel, P.J. 2000. Fundamentals of genetics. Addition Wesley Longman Publishers, USA.
6. Singh, B.D. 2004. Fundamentals of Genetics, Kalyani Publishers, Chennai.
7. Stansfield, W.D.1990. Theory and problems of genetics. Mc-Graw Hill Book Co., New York.
8. Strickberger. M.W. 1996. Genetics. Prentice-Hall of India Pvt. Ltd. New Delhi.
9. Verma, P.S. and V.K. Agarwal. 2007. Genetics. S. Chand and Company Ltd. / New Delhi.

Wood Anatomy and Identification 2 (1+1)

Objective

To develop basic understanding on wood identification, anatomical characterisation of both Gymnosperms and Angiosperms

Theory

Basics and introduction of wood anatomy - Classification of plant kingdom - Gymnosperms versus angiosperms - Kinds of woody plants. The plant body - a tree and its various parts. Meristems -Promeristem, primary meristem, secondary meristem. Simple tissues - Parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body - Typical stems and roots of dicots and monocots. Basic process in tree growth - Vascular cambium – Expansion of cambium layer – Duration of cambial activity - Secondary growth in woody plants. Mechanism of wood formation - Special reference to typical dicot stem. Ray initials and fusiform initials -Anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood - Sapwood, heartwood, pith, early wood, late wood, growth rings, dendrochronology, wood rays, Knots, Grain orientation etc - Sapwood versus heart wood - Anatomical differences. Transformation of sapwood to heartwood - Factors affecting transformation. Prosenchymatous elements, tracheids, vessels, fibers, parenchyma and rays, resin canals, gum canals, latex canals and infiltrants in wood.

Three dimensional features of wood - Transverse, tangential and radial surfaces. Elements of wood cell walls. Structure and arrangement of cells - Simple pit and bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers - Classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood. Reaction wood. Bark structure - Composition and functions.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (Woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers and examination of wood samples. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Tamil Nadu.

Suggested Readings

1. Brown, H.P. 1995. Text Book of Wood Technology, Vol I and II International Books and Periodical supplement service, New Delhi.
2. Haygreen, J.G and Bowyer, J.L. 1982. Forest Products and Wood Science-An Introduction. The Iowa State University press, America P.495.
3. Hoadley, B. 2000. Identifying Wood-Accurate results with simple tools. Taunton Press, Newtown, USA. 223p.
4. Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th edn. McGraw-Hill. New York, USA: 722p.
5. Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

Forest Measurements and Inventory 3 (2+1)

Objectives

1. To impart various methods of measurements on standing, felled trees, crops and determining the volume of trees
2. To inculcate knowledge on volume table preparation for trees

Theory

Forest Mensuration - Definition and objectives - Scales of measurement - Units of measurements - Precision, bias and accuracy aimed and reasons. Diameter and girth measurements - Breast height measurements - instruments used. Measurement of height - Definitions - Methods of measurement of height - Ocular - non instrumental and instrumental methods. Sources of error in height measurement - Height measurement of leaning trees. Tree stem form - Metzger's theory - Form factor - Types of form factor - Form height, form quotient - Form class. Area measurement in

trees and timber - Cross sectional and basal area. Volume measurement of standing trees – Volume of felled logs - Branch wood. Volume table - Definition - Preparation of volume tables - Graphical, regression equation and alignment chart method. Forest inventory - Sampling techniques and methods - Measurement of crops - Sample plots. Increment - CAI and MAI - Increment Percent - Instruments and methods - Increment Borer. Stump analysis - Stem analysis - Increment Boring. Tree crops - Measurements - Objects - Crop diameter, crop height, crop age and crop volume. Yield table and stand table.

Practical

Determination of length - Measurements of diameter. Girth and basal area of trees using Callipers, Tape, Ruler, Penta Prism, Tree Calliper, etc. Measurement of height using non instrumental method - Shadow method and Single pole method. Measurement of tree height using instrumental methods - Haga altimeter - Clinometer - Blume leiss Hypsometer - Laser Hypsometer. Volume determination of standing and felled trees. Exercise on Stump analysis and Stem analysis. Annual ring counting in trees using ring borer. Preparation of volume tables - Local volume table. Yield Table - Preparation and Application. Point sampling - Theory - Wedge prism. Total enumeration and partial enumeration - Kinds of sampling and elementary statistical computations.

Suggested Readings

1. Chaturvedi, A. N. and L. S. Khanna. 1982. Forest Mensuration. International Book Distributors, Dehradun.
2. Manikandan, K and S. Prabhu. 2014. Indian Forestry. A breakthrough approach to Indian Forest Service. Jain Brothers, New Delhi.
3. Eugene, T. Forest Mensuration. McGraw Hill Company.
4. Panwar and Bharadwaj. Handbook of Practical Forestry. Updesh Purohit for Agrobios (India), Jodhpur.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviors, personality and Organizational Behavior.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
6. Mile, D J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D R, 2009, Social and Personality Development (6^{th} edn). Belmont, CA: Wadswor.

Environmental Studies and disaster Management 3(2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters.

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti. P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. (In Press). Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. Prasanthrajan M, and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008
6. Prasanthrajan M, 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

Entrepreneurship Development and Business Management **3 (2+1)Objectives**

- To provide student an insight into the concept and scope of entrepreneurship
- To expose the student to various aspects of establishment and management of a small business unit
- To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries. Agro-industries, Interaction with successful entrepreneurs, Agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V, 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Desai, Vasant, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. Hous
4. Grover, Indu, 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Gupta CB, 2001, Management Theory and Practice. Sultan Chand andSons.
6. Khanka SS, 1999, Entrepreneurial Development. S. Chand andCo.
7. Mehra P, 2016, Business Communication for Managers. Pearson India, New Delhi.

8. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D, 1995 Effective Managerial Leadership. Deep andDeep Publ.
10. Singhal R.K., 2013, Entrepreneurship Development andManagement, Katson Books.
11. Tripathi PC and Reddy PN, 1991, Principles of Management. Tata McGraw Hill.

Skill Enhancement Course (Indicative SEC Courses II) 4 (0+4)

- Clonal Seedling Production
- Forest Based Industrial Training
- Urban Forestry Designing and Planning
- Wood Working and Carpentry
- Wood seasoning and Preservation Technology
- Zoo Management
- Wild and Commercial Beekeeping
- Mining Afforestation
- Advanced Wood Working
- Lac and Tassar Cultivation

National Cadet Corps (NCC-II) 1 (0+1)

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing

skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Post-II Semester

Internship (Only for exit option for award of UG-Certificate) 10(0+10)-10Week

General objective

To provide students with an opportunity to put into practice the skills they have learned while in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and consider having their own startups.

Specific objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills in the job interview process
5. Explore career alternatives prior to graduation.

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres,

prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Silviculture of Trees 2 (2+0)

Objective

To impart basic knowledge on silviculture and regeneration of broad leaved and conifer tree species

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Acacia nilotica, Acacia catechu, Azadirachta indica, Dalbergia sissoo, Shorea robusta, Tectona grandis, Terminalia* species, *Anogeissus latifolia, Pongamia pinnata, Bassia latifolia, Calophyllum inophyllum, Simarouba glauca* and *Albizia lebbeck*- Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Bambusa* species, *Calamus* species, *Dendrocalamus strictus* and *Melocanna bambusoides.* Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of Northern region trees: *Abies pindrow, Celtis australis, Diospyros* species*, Grewia* species*, Picea smithiana, Pinus wallichiana, Populus* spp.*, Quercus* species*, Robinia pseudoacacia, Eucalyptus* spp. and *Salix* spp. Eastern trees region trees: *Neolamarckia cadamba, Chukrasia tabularis Cryptomaria japonica, Dipterocarpus* species, *Mesua ferrea, Morus laevigata, Pinus kesiya, Shorea assamica* and *Terminalia myriocarpa*. Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Acacia* spps. (Wattles), *Anacardium occidentale, Casuarina* spp., *Dalbergia latifolia, Pterocarpus* spp., *Eucalyptus* spp., *Santalum album, Swietenia mahogany* and *Tamarindus indica*. Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of the following conifer species: Tropical pines, *Abies pindrow, Picea smithiana, Cedrus deodara* and *Pinus roxburghii.*

Suggested Readings

1. Champion, H.G. and A.L. Griffith. 1989. Manual for General Silviculture for India.
2. Dwivedi, A.P. 1993. A Text Book of Silviculture, International Book Distributors, Dehradun.

3. Luna, R.K. 2005. Plantation trees International Book Distributors, Dehradun.
4. Troup, K.S. 1984. The Silviculture of Indian Trees- Volume I, II and III. Controller of Publications, New Delhi.
5. Ralph D. Nyland. 1996. Silviculture concepts and applications. McGraw-Hill, New York.

Wood Science and Technology 2 (1+1)

Objectives

1. To make students aware about the problems related to wood as basic material to manufacture various useful products
2. To understand the wood treatment requirement

Theory

Wood – Natural defects in wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Wood water relationship - Hygroscopic nature of wood – Free and bound water – Shrinkage and swelling - Fibre saturation point - Equilibrium moisture content. Moisture content determination. Durability and treatability of wood – Natural defects and wood deterioration. Wood seasoning; merits, principles, seasoning of timber – Introduction and history of seasoning in India - purpose and scope -Factors influencing seasoning, Mechanism of drying and types; Selection and preparation of material for seasoning. Air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules; Special seasoning methods, Seasoning defects and their control. Wood biodeterioration. Classification of timbers based on durability and seasoning behavior. Wood preservation; Introduction– Development and progress of wood preservation in India - mechanism of wood preservation. Preparation of wood for preservative treatment principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage, Durability of timbers. Methods of application of wood preservatives-Non pressure Methods-Brushing-Steeping-Hot and cold bath process – Diffusion Process-Momentary Dip Process-Sap displacement method - Boucherie method. Pressure Method-Full cell process - Empty Cell Process-Merits and demerits.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories. Visit to timber depot/saw mill to study the stacking methods and various defects in wood. Determination of moisture content by different methods. Visit to Wood seasoning unit to study the various types of seasoning methods and Safety aspects. Exercise on fixing seasoning schedule for timbers under steam heated kiln and FRI solar heated kiln seasoning method. Visit to wood preservation unit to study the different methods of application of wood preservatives. Study on the environmental health and safety aspects of wood preservatives.

Non pressure and pressure methods of application of preservatives. Seasoning and preservative treatments for important tree species.

Suggested Readings

1. Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.
2. Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.
3. Divya, M.P., Parthiban, K.T., Packialakshmi, M. and S. Krishnamoorthi. 2022. Text Book on Wood Products and Utilization. Scientific Publishers, Jodhpur (ISBN No.: 9789392590795).
4. FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.
5. Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.
6. USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p

Forest Microbiology 2 (1+1)

Objective

To impart basic knowledge about the microbiological associations involved in promoting the growth of trees.

Theory

Forest soil Microbes. Rhizosphere concept- ecto and endo rhizosphere, rhizoplane and rhizosphere effect (R:S ratio); spermosphere - seed surface microflora and phyllosphere - lichens, algae and leaf nodulating microorganisms. Soil microbial biomass in different forests; qualitative and quantitative nature of microorganisms in various forest ecosystems - their role in improving soil nutrient availability and plant growth. Carbon cycle - forest litter / organic matter – types; composition of organic matter / litter. Biochemistry and microbiology of litter / organic matter decomposition under aerobic - tropical, subtropical and temperate forest ecosystem; and in anaerobic conditions – mangrove and swamp forests. Role of autotrophic microorganisms in sequestering carbon in forest soils. Biochemical cycling of nitrogen. Nitrogen fixation - free living, associative and symbiotic diazotrophs. Nitrogen fixing trees- leguminous trees with *Rhizobium* and non-leguminous / actinorhizal trees with *Frankia* and their nitrogen fixing capacity. Biochemistry and microbiology of nitrification and denitrification and their impact on nitrogen availability in aerobic and anaerobic forest ecosystem. Biochemical cycling of phosphorus. Microbial transformation of phosphorus – mycorrhizae – types; mycorrhizal status of tropical, sub tropical and temperate forest trees; nutritional and non-nutritional effects of mycorrhizae; mechanism of enhanced nutrient uptake and plant growth. Phosphate solubilisers - types – mechanism of phosphate solubilization.

Microbial transformation of iron and sulphur. Microbial interactions in soil. Microbial inoculants - mass production, storage methods ISI / BIS standards and quality control; problems and constraints in production and application. Role of microbial inoculants in afforestation program. Generation of biofuels – Development of biological conversion technologies – Biodiesel – Microorganisms and raw materials used for microbial Oil production – Treatment of the feedstocks prior to production of the Biodiesel – Current technologies of biodiesel production. Bioethanol – Properties – Feedstocks – Process technology – Pilot plant for ethanol production from lignocellulosic feedstock – Biomethanol – Principles, materials and feedstocks – Process technologies and techniques – Advantages and limitations.

Practical

Isolation and enumeration of rhizosphere and soil microorganisms. Quantification of heterotrophic microbial population and total microbial activity of different forest ecosystem. Isolation of cellulose and lignin degrading microorganisms from forest floor. Isolation of free living diazotrophs - Azotobacter and Beijerinckia from soil. Isolation of Azospirillum and Phosphobacteria. Study of root nodules of leguminous trees. Isolation of Rhizobium from root nodules of tree legumes. Study of root nodules of non-leguminous trees and isolation of Frankia from *Casuarina equisetifolia* / *Alnus nepalensis*. Examination of ecto- and endo-mycorrhizae from different forest soils. Bio composting of leaf litter. Mass culturing of bacterial and fungal inoculants- microbial inoculation techniques.

Suggested Readings

1. Alexander, M. 1985. Introduction to Soil Microbiology. John Wiley and Sons, New York. New Delhi.
2. Paul, E. A. 2007. Soil microbiology, ecology, and biochemistry, 2nd edn. Academic Press
3. Pelczar, M.J., Chan, C.S and Krieg, N.R. 2003. Microbiology, Tata McGraw Hill Pub. Co. Ltd.,
4. Prescott, L.M., Harley, J. P. and Kelin, D.A. 2000. Microbiology, 4th edn, McGraw Hill.
5. Shukla, G. and A. Varma. 2010. Soil Enzymology (Soil Biology), Springer Verlag.
6. Singh, R.P.2010. Microbiology. Kalyani Publishers. Ludhiana.
7. Smith, S.E. and D.J. Read. 1997. Mycorrhizal Symbiosis. 2nd edn. Academic Press, San Diego.
8. Subba Rao N.S and Dommergues, Y.R. 2000. Microbial interactions in Agriculture and Forestry. Vol. II. Oxyford and IBH Publications Co. Pvt. Ltd. New Delhi and Kolkata.
9. Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. 3rd edn. Oxford and IBH Publishing Co. PVT Ltd., New Delhi. Bombay and Kolkata.
10. Tate, R.L. 1995. Soil Microbiology. John Wiley and sons, Inc New York.
11. Tauro, P. Kapoor, K.K. and Yadav, K.S. 1989. An Introduction to Microbiology, Wiley Pub.

Forest Soil and Nutrient Management 2 (1+1)

Objectives

To impart knowledge about the forest soil fertility and productivity and to enhance the nutrient status in soil.

Theory

Forest soils vs cultivated soils - Soil fertility and productivity - Properties of soils under different forest ecosystem - Arnon's criteria of essentiality. Classification of nutrients based on Arnon's criteria - Sources of nutrients and forms of nutrients. Nutrient transformations – Mineralization and immobilization - Availability and uptake of nutrients by plants – Fixation and loss of nutrients – Nitrogen, Phosphorus and Potassium cycles in soil. Available forms of secondary nutrients – Ca, Mg and S. Availability of micronutrients. Deficiency and toxicity symptoms and their corrective measures for nutrients. Relationship between nutrient concentrations and plant growth. Deficiency, Hidden hunger, Critical limit, Sufficiency level, Excessive and Toxicity limits. Soil Reaction (pH) and Nutrient availability. Cation exchange – CEC – adsorption, desorption. AEC – calculation of BSP. Significance of CEC and exchangeable cations with respect to soil fertility. Factors affecting CEC in soils. Nutrient Interaction – Definition – Mechanisms, types of interactions between macro and micronutrients, chelates and plant nutrition. Diversity of organisms in the soil – Factors affecting their growth and activity in the soils viz., Organic matter, oxygen, temperature, pH etc. Soil Macro organisms - Earthworms, Ants and termites and plant roots, Soil micro animal's nematodes, protozoa etc. and their role in soil. Soil microorganisms- Prokaryotes (Bacteria and archaea), fungi, actinomycetes, Cyanobacteria (Blue-green algae) etc. in the soil ecosystem their distribution. Atmospheric N fixation by organisms and Nitrogen fixing tree species. Mycorrhiza - Types of Mycorrhiza and Beneficial effects on plant nutrition. Concepts of rhizosphere - Rhizodeposition and Phyllosphere. Organic matter decomposition - Factors affecting organic matter decomposition – Stages of organic matter decomposition - C: N ratio of organic matter, its importance and nutrient availability - Role of organic matter in the Forest soil improvement. Nutrient management - Nutrient Use efficiency – Importance. Methods of soil fertility evaluation – Diagnosis of deficiency symptoms, Biological test, Soil testing and Rapid plant tissue analysis and Fertilizers recommendation. Soil fertility management: Optimum, efficient and balanced use of nutrients. INM – SSNM – Fertigation - Crop rotation, Nutrient management through fortification of fertilizers. Permanent manurial experiments - LTFE experiments. Methods of fertilizer recommendations.

Practical

Available N, available P_2O_5, available K_2O, and micronutrients from the soils and interpretation of their results. Determination of CEC and derivation of ESP. Estimate the gypsum requirement of sodic soils and lime requirement of acid soils. Enumeration of soil micro-organisms -Estimation of N fixing micro-Organisms-Organic matter decomposition.

Suggested Readings

1. Brady, N.C. The Nature and Properties of Soils. Mac Millan Pub. Comp. New York.
2. Burges, A. and Raw, F. 1967. Soil Biology. Acad. Press, New York.
3. Mengel, K. and Kirkby, A. 1978. Principles of Plant Nutrition. International Potash Institute, Switzerland.
4. Pritchett and Fisher R.F. 1987. Properties and Management of Forest Soils. John Wiley, New York.
5. Tisdale, L. S. Nelson, L.W. and Beaton, J. D. 1985. Soil Fertility and Fertilizers. Macmillan Publishing Company, New York.

6. Young, A. 1989. Agroforestry for Soil Conservation. CAB International, U.K.

Forest Survey and Engineering 2 (1+1)

Objectives

1. To educate the students on different types of surveying and latest technologies involved in surveying
2. To impart basic knowledge on building materials, construction, roads and bridges, its types and its adoptability in forest areas.

Theory

Surveying – Scales - Measurement of distances - Chains – Cross staff - Chain surveying - Chaining on plain and sloping lands - Chaining around obstacles - Offset – Measurement of angles – Bearings and Meridians. Compass – Types: Prismatic and surveyor's compass. Compass surveying - Traversing – Closed and open - Methods of surveying - Radiation, intersection and traversing. Local attraction - Theodolite surveying – Methods: Repetition and reiteration. Measurement of horizontal angles and distances, vertical angles. Levelling - Utility and scope – Definitions - Methods - Levelling instruments - Dumpy level - Temporary and permanent adjustments. Bench marks – Types. Reduction of levels - Rise and fall method - height of collimation method. Topographical surveying - Methods of contouring - Characteristics and use of contours - Maps and Map Projections – Basics of Total Station – EDM - GPS - Study of minor survey instruments. Aerial Surveying – Concept - Stereo Photogrammetry – Aerial photogrammetry – Overlaps – Scale of photographs – Vertical and titled photographs distortion in aerial photographs – Stereostopic vision – Photo interpretation – Application. GPS Surveying –Basic Concept – Space, control and user segments – Satellite configuration – Signal structure – Orbit determination and representation – Hand held and geodetic receivers – Field work procedures – Data processing and application. Materials for construction – Bricks, Lime and Cement - Mortar – Concrete – Foundation and types -Bearing Capacity of soil – Brick masonry - Stone masonry - Roofs – Floors –Dampness – Anti termite treatment in buildings - Precautions – Safety measures. Estimating and costing - PWD schedule of rates – Preparation of estimate. Road – Introduction, definitions, types, road profile - Demarcation, alignment in plains and hills, curves and drainage. WBM and earthen road, road maintenance and road signs - Retaining wall – Types and construction features - Bridges – Principles of construction, selection of site and types - Culverts – Types.

Practical

Chain surveying –study of different types of chains - chaining on plain and sloping lands - chaining around obstacles - field work – plotting. Cross staff surveying and computation of areas. Compass surveying - radiation, intersection and traversing. Theodolite surveying - measuring horizontal angles and distances, vertical angles. Levelling – study of instruments - reduction of levels - rise and fall method - height of collimation method. Study of coordinate system – Aerial surveying - Total Station – GPS Surveying – Preparation of contour maps - Brick, Lime and cement manufacturing - Visit to Brick and Lime kilns - Design of foundation - Brick and stone masonry – section showing different components of brick and stone masonry. Types of roofs – trusses – king and queen post truss. Drawings of different types of windows and doors. Preparation of estimates for small structures and measurement book entries.

Suggested Readings

1. Arora, K.R. 2007. Surveying Vol. I and II. Standard Book House, Delhi-6.
2. Basak, N.N. 1994. Surveying and levelling. Tata McGraw hill publications, New Delhi.
3. Deodhar S.V. and Singhal. 2001. Civil Engineering Materials. Khanna Publishers, New Delhi.
4. Duggal, S.K. 2008. Building Materials. New Age International Publishers, New Delhi
5. Masani, N.J. 2001. Forest Engineering without Tears, Nataraj Publication, Dehra Dun.
6. Ram Prakash. 1997. Forest Surveying, International Book Distributors, Dehra Dun.
7. Rangawala, S.C and Rangwala, P.S. 1985. Surveying and Leveling, Character Publishing House, Anand.
8. Rangwala. S.C. 1991. Estimating and costing. Charotar book stall, station road, Anand.
9. Rangwala. S.C. 2000, Building construction, Charotar publishing house, Anand.

Wildlife Sciences 3(2+1) Objective

To develop basic understanding on Reptiles, Aves and Amphibians and their ecology, behaviour and the habitat.

Theory

Wildlife – Definition - Types - Free living, Captive, domesticated and feral animals - History of Wildlife studies in India - Evolution of geological time scale - Significance - Classification of Indian Mammals - Phylum Cordata - Typical attributes of Cordates - Classification of Phylum Cordata - Description of Mammal, Reptiles, Aves and Amphibians Basic requirements of wildlife - food, water, shelter, space, limiting factors - Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals - Impact of Water and Temperature; Animal behavior - Systems of perception - Thermo receptors - Tactile receptors - Auditory receptors - Visual receptors - Chemo receptors - Biological rhythms - Circadian - Tidal - Lunar. Kinds of behavior - Innate - learning methods of communication - Mimicry - Aggressions - Social groups - Coronial - Fossorial - Seasonal - Aquatic adaptations. Niche- Territory - Home range - Cursing radius - Edge - Eco tone - Juxtaposition - Interspersion - Carrying capacity - Cover and its types - Habitat analysis and evaluation - Alternate Habitat AnalysisHabitat Improvement - Manipulation of forestry operations - Food and Water development - Cover construction - Shelter improvement.

Practical

Visit to various protected areas and observations on the morphological, behavioural, feeding and reproductive activities of different species of wild animals in India. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera trapping, for identification, determination of age and sexing of animals including the small mammals. Faecal analysis of wild animals.

Suggested Readings

1. Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.

2. Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.
3. Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA. International Zoo Books, Published by New York Zoological Society, New York
4. Johnsingh, A.J.T. and Manjrekar, N. 2014. Mammals of South Asia. Vol. I. University Press, 614p
5. Johnsingh, A.J.T. and Manjrekar, N. 2015. Mammals of South Asia. II. University Press, 739p
6. Krebs, C. and Davis, N. 1978. Introduction to behavioral ecology. Oxford University Press.
7. Menon, V. 2014. Indian Mammals: A field guide. Hachette. 528p.
8. Mittermeier, R.A., Rylands, A.B. and Wilson, D.E. 2013. Handbook of the Mammals of the World -Volume 3. Lynx Edicions. 952.
9. Prater, S.H. 1971. The Book of Indian Animals. Oxford University press, Bombay. 324p.
10. Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.
11. Wilson, D.E. and Mittermeier, R.A. 2009. Handbook of the Mammals of the World - Volume 1. Lynx Edicions. 728.
12. Wilson, D.E. and Mittermeier, R.A. 2011. Handbook of the Mammals of the World - Volume 2. Lynx Edicions. 886.

Forest Health and Protection 2 (1+1)

Objective

To create professional knowledge on various disturbances, problems and other issues to forest and the associated heath and protection

Theory

Disturbances – Importance and Scope – Causes and kinds of forest disturbances – Problems due to the forest disturbances - Factors that determines the forest protection. Deforestation – Causes of deforestation – Extent and causes of forest and land degradation – Extent of global and national forest cover changes – Effects of deforestation – Strategies to reduce and control deforestation – Preventive and remedial measures. Shifting Cultivation – Causes – Extent of shifting cultivation areas – Methods of shifting cultivation areas – Impact of shifting cultivation - Preventive and remedial measures – Alternative land use practices to shifting cultivation. Forest fires – Characters, Components, Causes, Types – Status of forest fire in Global and Indian scenario – Injuries and Impact – Fire detection methods. Forest fires and its effect on forest ecosystems. Fire suppression – Firefighting equipment – Fire control policy and objectives. Fire fighting in other countries. Post fire suppression operations -Legal provisions – Economics of fire protection. Encroachment - Types, control of encroachment, illegal felling of trees – Legislation mechanism in encroachment. Damage caused by domestic and wild animals. Defective management – Errors in execution – Preventive measures. Invasive alien species in forests – Its effect on forest ecosystem - management techniques. Community forest protection – Role of forest dwellers and Village Forest committee (VFC). Awareness creation. Community participation in forest protection.

Practical

Visit to deforestation and shifting cultivation areas in nearby forest and study about its causes and prevention. Visit to forest areas with fire damages. Study of fire registers, records and fire

monitoring stations. Fire line creation in forest. Study of fire reporting methods and instruments. Visit to fire station - Study and acquaint with machinery used for fire control. Application of recent techniques in fire forecasting, monitoring and mapping. Study of problems in forest encroachment. Field study of role of forest dwellers in forest protection. Visit to Community Forest protection area. Identification of weeds, parasites and epiphytes – Its impact in forest. Tree transplanting techniques and revival packages in wind and cyclone damaged trees. Symptoms of damages, causes their management methods.

Suggested Readings

1. Basher, A.E.S. (1983). Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New Delhi.159p.
2. Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
3. Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.
4. Khanna, L.S. (1988). Forest Protection. Khanna Bandhu, Dehra Dun.206p
5. Parthiban, K.T., M. Suganthy and N. Krishna Kumar. (2019). Forest Protection – Principles and Application. Jain Brothers, New Delhi (ISBN No.: 9788183602952).

Arboriculture 2 (1+1)

Objective

To impart skill and expertise on urban tree management coupled with the knowledge on landscape management

Theory

Arboriculture – Tree identification and principles. Tree anatomy – Structure, function and mechanics. Tree physiology – Environmental factors affecting Photosynthesis, Respiration and Transpiration. Selection of trees – Tree propagation – Tree planting – Various tree planting techniques – Water and Plant Growth – Tree guards. Soil and Tree growth – Fertilizing Trees and Compacted Soils – Soil Nutrition. Tree disorder and Health – Frost protection – Wind damage minimizing – Mulching and watering – Diagnosing and management. Health disorders in trees – Pest and diseases in urban trees – Identification and diagnosing – Integrated pest and disease management. Tree pruning – Techniques, essential and safety – Basic pruning principles of woody plants – Canopy architecture: Crown cleaning, crown reduction, crown lifting. Felling a whole tree and felling in sections. Burlapping techniques. Arboricultural equipment – Pruning tools: Secateurs, Hand saws, Power tools – Felling tools: Chain saws, Hedge trimmers, Climbing equipment (Ladder, harness, rope, belt, sprus, etc.) – Tool maintenance. Tree surgery – Types of surgery: Cavity treatment, rods, cables, etc. – Propping – Treating bark wounds – Removing large branches. Climbing techniques – Preparing to climb, how to climb and anchoring point. Knots – Tree surgery safety. Workplace safety – Protective equipment: Personal protection, gloves, eyewear, hearing protection, skin protection, etc. Handling tools and machinery safety. Risk management, legal issues, and aesthetic considerations. Landscaping – Principles and elements – Types of landscape designs – Formal: Persian and Mughal designs – Informal: British and Japanese. Landscape components – Plant and other components – Lawn, pergolas, hedges, edges, topiary, balloon, arbours, carpet beds, trees,

flower beds, annuals and climbers. Practices of landscaping. Tools and implements for landscaping. Specialised gardens - Butterfly, water, bog or marsh, terrace, roof, sunken, indoor and rock. Planning and planting programs in institutional and industrial complexes, roads, bridges, parking area and other structures.

Practical

Tree Identification and principles – Tree Propagation – Tree planting techniques –Canopy architecture – Tree pruning techniques. Burlapping techniques. Arboricultural equipment – Pruning tools and Feeling tools – Tool maintenance. Tree surgery: Cavity treatment, rods, cables, etc. Climbing techniques – Tree climbing and equipment – Preparing to climb, how to climb and anchoring point. Common Insect pests and diseases to trees and woody plants. Landscaping – Types of landscape designs – Tools and implements for landscaping. Specialised gardens. Visit to different landscapes and gardens. Workplace safety and Protective equipment.

Suggested Readings

1. Harris, R. W. (1992). Arboriculture: integrated management of landscape trees, shrubs, and vines (No. Ed. 2). Prentice-Hall International.
2. Konijnendijk, C., Nilsson, K., Randrup, T., and Schipperijn, J. (Eds.). (2005). Urban forests and trees: a reference book. Berlin, Heidelberg: Springer Berlin Heidelberg.
3. Shigo, A. L. (1991). Modern arboriculture: a systems approach to the care of trees and their associates. Shigo and Trees, Associates.
4. Watson, G. W., and Himelick, E. B. (1997). Principles and practice of planting trees and shrubs (pp. 107-113). Savoy, IL: International Society of Arboriculture.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan,

Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan–left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan

- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Skill Enhancement Course (SEC) **`2(0+2)**

- Timber Conversion
- Value addition of NTFPs
- Briquetting Technology
- Forest Fire Management
- Activated Carbon Technology
- Wood carving through CNC Technology
- Burlapping Technology
- Micro Forest
- Import and Export of forest Products
- e-Timber Market
- Community Forest
- Human Animal Ecosystem Interface
- AR/VR Module Creation in Forestry
- Forest Resource Assessment
- Multifunctional Agroforestry
- Biofuels Technology through forestry

Semester IV

Commercial Forest Products and Utilization 3 (2+1)

Objectives

1. To develop an understanding on the wood and wood panel related industries
2. To understand the secondary timber species, composite wood products for structural usage, new generation wood composite and improved woods

Theory

Indian Timbers - Growth of wood-based industry in India and its relation to Indian economy – Production of roundwood and engineered wood in global and Indian scenario – National, International trade of important primary timber species – Volume of Import and Export details of wood and wood panels in India – Present status of wood and wood panel industries in India and Global scenario. Description of different forest-based industries – Paper and Pulp, Furniture, Bamboo, Sports Goods, Pencil, Match wood and Splint making and Composite wood industries. Primary conversion: Sawing techniques, kinds of saws – Wood Machining – Wood working tools used in wood working (Parting, Slicing, Shaping, Measuring and marking tools). Various stages in wood working – Wood Joinery – Finger Jointed Lumber – Veneer Production Process – Rotary cutting and Slicing – Types of veneer and their uses – Advantages of the use of veneered panels in wood products – Veneer jointing – Veneer grading – Storage and handling of veneers. Modern technologies for furniture making – Computer Numerical Control (CNC). Production, properties, properties and application of Plywood, Particle board, Sandwich board, Core board, Flake board, Fibre board (LDF, MDF, HDF). Production, properties, properties and application of Glue Laminated Timber (GLT), Structural Composite Lumber (LVL, PSL, LSL). Laminated wood – Multispecies laminates – Types of laminates – Matte finish laminates. Textured laminate, Gloss-finish laminates, Metallic laminate, PVC-finish laminate, Acrylic-finish laminates and Exterior laminates. Laminated wood from bamboo and bamboo laminates. Acoustic panels from laminated wood – Densified laminated panels. Wood adhesives – Types, characteristics and application. Eco friendly wood composites – Lignocellulosic composites – Adhesives for composites – Natural fibres – Wood plastic composites – Reinforced composite structures – Nano based wood composites – Bioactive wood polymer composites, Biotechnological production of wood composites – Wood polymer; Hybrid composite processing. Cross – Laminated Timber (CLT), Wood Plastic Composites (WPCs), Wood Inorganic Composites (WIC) approach. Chemical modification of wood, Thermal modification, acetylation and Furfurylation processes – Nanomaterials – Carbon nanotubes and cellulose nanofibres for wood modification, Impregnation / Polymerisation, microwave modification, Plasma and Laser for wood modification, Enzymatic modification. Scarification of wood – Wood Molasses, alcohol and yeast – Biochar and activated carbon technology

Practical

Visit to saw mill to study primary conversions of wood and Wood working industry for studying basic wood carpentry tools and application - Visit to pulp and paper industry, furniture industry, industrial plantations, pencil industry, matchwood industry, plywood industry, Briquette making industries and Gasification industries to study the production, manufacturing, grades and training process - Study the production, properties, and application of Particle board, Sandwich

board, Core board, Flake board, Fibre board, Glue Laminated Timber, Structural Composite Lumber, Laminated wood, PVC-finish laminate, Acrylic-finish laminates and Exterior laminates. Wood Plastic Composites (WPCs), Wood Inorganic Composites (WIC) approach. Chemical modification of wood - Carbon nanotubes and cellulose nanofibres for wood modification - Scarification of wood - Biochar and activated carbon technology.

Suggested Readings

1. Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd edn. Miller and Freeman Publication, Inc. USA. 388p.
2. FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
3. Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

Forest Ecology and Management 3 (2+1)

Objectives

1. Develop basic understanding on ecology and its application in Forest ecology, biodiversity and conservation.
2. Develop a working knowledge on forest ecosystem, productivity and conservation forest bio resources
3. Be able to apply this knowledge base to unknown situations related to forest ecology

Theory

Definitions- interactions of biotic and abiotic components. Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment- major abiotic and biotic components and their interaction, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity. Speciation- sympatric and allopatrty. Population growth models-. Population distribution- Characters of forest communities. Community ecology species interactions. Ecological succession-Definition-terminology, basic concepts, theories of succession- climax vegetation types. Production ecology – primary and secondary production – Paterson's productivity index. Autecology of important tree species. Biodiversity – Definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, World mega biodiversity countries. Biodiversity of Western Ghats and Eastern Ghats. Measurement of diversity and diversity indices. Endemism – categories of endemism Rarity and Extinction of species - threat values of species - categories of existence. Principles of conservation biology, ex-situ and in-situ methods of conservation. Genetic and evolutionary principles in conservation. Sacred groves-concept-uses. Biosphere concept. Conservation – efforts in India and worldwide. - National Biodiversity Authority (NBA) - Salient features of NB Act - Convention on biological diversity (CBD) - Access and benefit sharing (ABS).

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion

among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Forest productivity estimation methods through harvest, Leaf area, LAI. Study of succession in field and water bodies; Visit to different ecosystems. Recording light transmission in forest relative to open fields. Estimation of growth and productivity of Plantation/site. Field data processing and Analysis-Calculation of IVI, Diversity indices Assessment of tree volume and carbon sequestration. Visit to *ex situ*, *in situ* conservation and Nilgiri biosphere reserve.

Suggested Readings

1. Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p.
2. Kimmins, J.P. 1976. Forest Ecology. MacMillan.
3. Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p.
4. Misra, K. C. 1974. Manual of Plant Ecology. Oxford and IBH Pub Co. New Delhi etc. 491p.
5. Montagnini, F. and Jordan, C.F. 2005. Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.
6. Nautiyal, S. and Koul, A.K. 1999. Forest Biodiversity and its Conservation Practices in India. Oriental Enterprise.
7. Odum, E. P. 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p.
8. Saggwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India. 368p.
9. Sharma, P. D. 2013. Ecology and Environment. 11th edn, Rastogi Publications, Meerut.

Tree Harvesting and Ergonomics 2 (1+1)

Objective

To provide an understanding about the tools and implements used for logging mechanism, reduced impact during logging, transportation, grading and storage of felled logs

Theory

Definition, history, objective, and scope of harvesting, harvesting plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction – Phases of harvesting. Tools and Implements used in harvesting operation; traditional and improved tools, axes, saws, types of saws, accessory implements, mechanized felling machines and operations. Felling rules, felling season, felling methods, safety rules Work contracts related to felling and removing (Contract system, convener systems) etc. Conversion, cross cutting, hand and machine sawing, conversion of specialized logs, measurement and description of converted material. Recent trends in timber harvesting. Reduced impact logging (RIL), Concept - scope and objectives – impediments to adoption - difference between reduced impact logging and conventional logging - Criteria and Indicators - operations and ITTO guidelines - Steps beyond reduced impact logging towards Sustaining timber yield (STY) – Recent developments. Timber logistics; types and means of transport of timber, off and on road transportation; Minor transportation methods carts, dragging, skidding, overhead transport, ropeways, skylines. Major transportation methods, Transport by

road and railways. Transport by water; floating, rafting and concept of booms. Grading of timbers - storage and disposal of timber in the depots - Temporary and final storage. Timber Depots; types, layout and management. Protection from plants, animals and insect infestations – Diseases and their prevention. Systems of disposal of timber. Harvesting productivity – Economics of recovery – Cost of production – Constraints and Techniques used in harvest unit. Ergonomics: Definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipment, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Practical

Equipment and tools used in harvesting operations, their uses and their maintenance. Instructions regarding maintenance of various records and registers in harvesting operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipment used and process of conversion. Field exercise on uses of axes (Traditional and improved), saws (Manual and power operated), felling of trees. Field exercise on estimation of felling and conversion waste. Visit to industrial plantation to study the mechanized means of felling and conversion of trees. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to Timber depot to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Visit to Range Office to understand about transit permits for various types of forest produce. Cost of production of timber harvesting. Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of State Forest Department.

Suggested Readings

1. Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.
2. Forest Engineering Technology Program. 1996. Introduction to forest harvesting methods. Vancouver, BC: BCIT.
3. FRI (Forest Research Institute). 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
4. GFC (Guyana Forestry Commission). 2002. Code of practice for timber harvest. 2nd edn. Georgetown, Guayana, 42p.
5. Hakkila, P. 1989. Utilization of residual forest biomass. Springer-Verlag, Berlin. 567p.
6. Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
7. Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
8. Mehta, T. 1981. A Hand book on forest utilization. IBD, Dehradun
9. Sharma, P.K. 1991. Forest resource and its utilization in India. Mittal Publication, New Delhi

10. Staaf, K.A.G. and Wiksten, N.A. 1984. Tree Harvesting Techniques. DR W. Junk Publishers, Netherlands.
11. Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

Forest Policy and Legislation 2 (2+0)

Objective

To impart knowledge on various policies and acts related to forests

Theory

Necessity of a Forest policy in a country. General basis of formulation, various considerations. National Forest Policies of 1894, 1952 and 1988 their comparative study, basis of their formulation and after effects. Constraints in the implementation of Forest Policy in India. Need based law for implementation of policy. National Forestry Action Program, formulation and constraint in implementation and State Forestry Action Programs. Code of Criminal Procedure, 1973 - Definitions. Position of forest offences - Constitution and powers of Criminal courts and important sections. Code of Civil Procedure 1908 - Summons and discovery. Indian Penal Code, 1860 - Abetment of forest offences - Offences directly connected with forests and its produce and Protection extended by law to Forest Officers. Forest Law: legal definition. Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act. Detailed study of IFA 1927.Forest (Conservation) Act, 1980 and its amendments. The Biological Diversity Act, 2002, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and Environmental Protection Act, 1986. Brief description about other major forest laws of regional, national and international significance. National Green Tribunal.

Suggested Readings

1. Chaturvedi, A.N. 2011. Forest Policy and Law. Khanna Bandhu Publishers, Dehradun.
2. Negi, S.S. 1997. Forest Policy and Law, IBD, Dehradun.
3. Dutta, R. and Yadav, B. 2012. Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India
4. Ernakulam Shetty, B. J. 1985. A Manual of Law for Forest Officers, Sharda Press, Mangalore
5. Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths Wadhwa, Nagpur.

Statistical Methods 2 (1+1)

Theory

Basic concepts – statistics – variable – types and sources of data – classification and tabulation of data. Diagrammatic and graphical representation of data – simple, multiple, component and percentage bar diagrams, pie diagram – frequency polygon, frequency curve and histogram. Construction of frequency distribution tables. Measures of central tendency: arithmetic mean, geometric mean, harmonic mean, median and mode – merits and demerits. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation, and coefficient of variation – skewness and kurtosis – merits and demerits. Probability – basic concepts – additive and multiplicative

laws (without proof). Probability distributions – Discrete distributions: Binomial and Poisson. Continuous distribution: Normal distribution – definitions and properties. Sampling theory – population – sample – parameter and statistic – sampling distribution – sampling vs complete enumeration – Types of sampling – simple random sampling – selection of simple random sample using random number tables. Null and alternative hypothesis – types of errors – critical region and level of significance – degrees of freedom. Large sample test – single proportion and difference between two proportions – single mean and difference between two means. Small sample tests – F-test – t-test for testing the significance of single mean – independent t test and paired t test – chi square test for goodness of fit – chi square test for testing the association of attributes by m × n contingency table – 2 × 2 contingency table – Yates' correction for continuity. Correlation – Scatter diagram – Karl Pearson's correlation coefficient definition – computation – types of correlation and properties. Regression – simple linear regression – fitting of simple linear regression equation – properties of regression coefficient. Analysis of Variance (ANOVA) – assumptions – one way and two-way classifications. Basic principles of experimental designs – Completely Randomized Design (CRD) – Randomized Block Design (RBD) – Latin Square Design (LSD) – lay out, analysis, merits and demerits of the above-mentioned designs.

Practical

Formation of frequency distribution tables – Diagrammatic and graphical representation. Computation of different measures of central tendency and computation of various measures of dispersion for raw and grouped data – calculation of coefficient of variation (CV) – measures of skewness and kurtosis. Simple problems in Binomial distribution, Poisson and Normal distribution – Selection of simple random sampling. Large sample test for single proportion and difference between two proportions and Large sample test for single mean and difference between two means. t-test for single mean – t-test for testing the significance of two means for independent and paired samples – chi square test for goodness of fit and test for independence of two attributes in a contingency table – Yates correction for continuity – calculation of the correlation coefficient – fitting of simple linear regression equation – One way and two-way ANOVA – completely randomized design (CRD) – randomized block design (RBD) – Latin square design (LSD).

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition

based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark);Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Singh, Joginder, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agriculture Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS commands. Introduction of different operating systems such as windows, Unix, Linux, creating files and folders, file management. Use of MS-Word and MS Power Point for creating, editing and presenting a scientific document, handling of tabular data, animation, video tools, art tool, graphics, template and designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating database, preparing

queries and reports. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation, and management of health information through web. Use of smart phones and other devices in agriculture and human health warning systems. Hands on practice on preparation of decision support system for the above-mentioned aspects.

Suggested readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brother Publication.

*Skill Enhancement Course (SEC-IV) 2 (0+2)

- Wildlife Forensic Sciences
- Dendroenergy Generation
- Big Data Management
- Artificial Intelligence in Forestry Operation
- Specialty Seedling Production
- Woodlot Establishment and Management
- Tools for Consulting Forester's
- Application of Drone in Forestry
- Forest Certification
- Arboriculture
- Forest Project Designing and Analysis
- Wood Mechanics
- Mulberry and Non-mulberry based Silk Production
- Internet of Things (IoT) in Forestry
- Marketing and Economics of NTFPs
- Carbon financing projects

Post-IV semester

Internship (only for exit option for award of UG Diploma) 10 weeks 10 (0+10)

General objectives

To provide students with an opportunity to put into practice the skills they have learned while in the institute, so that in case they exit with UG-Diploma, they will be able to get proper engagement/ employment and consider having their own startups.

Specific objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills in the job interview process
5. Explore career alternatives prior to graduation

Activity

The students will have internship/ training for 10 weeks' duration either in the institute or in industry or related organisations. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester V

Tree Physiology 2 (1+1)

Objective

To impart basic knowledge on various functions and processes related to production, mineral nutrition, plant growth regulators and environmental stresses with reference to forestry.

Theory

Introduction to Tree Physiology and cell organelles - Plasma membrane, chloroplast, mitochondria, peroxisome and vacuole, Structure and role of water - Diffusion, osmosis, imbibition, plasmolysis, water potential and its components, Translocation of water, Ascent of sap, Stomata - Structure and function, Stomatal conductance and resistance, Water relations of forest trees, Transpiration from forest canopies – Evapo-transpiration models - Water use efficiency of forest stands. Criteria of essentiality - Classification of nutrients - Macro nutrients, micro nutrients, beneficial nutrients, Mechanism of nutrient uptake - Physiological functions, deficiencies and disorders of macro nutrients and micro nutrients, Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S. Photosystems, Light reaction - Photolysis of water and photo phosphorylation - Z scheme, Red drop and Emerson enhancement effect, Photosynthetic pathways - C3, C4 and CAM - difference between three pathways - Factors affecting photosynthesis - Photorespiration- pathway and its significance - Phloem transport, Munch hypothesis - Phloem loading and unloading – Glycolysis - TCA cycle- Oxidative phosphorylation. Plant Growth regulators – Classification and biosynthetic pathways, Sun plants and shade plants, shade tolerance, Carbon cycling, Carbon balance and dry matter production in forest trees. Classification of stress - Water stress - Mechanism of drought tolerance and drought resistance - Physiological basis of drought avoidance and tolerance – Temperature stress - Temperature influence on forest development - Low and high temperature- Physiological adaptations for high temperature, Salinity stress - Effects on tree growth tolerance mechanisms.

Practical

Preparation of different types of solutions, Measurement of plant water potential by different methods, Estimation of chlorophyll, Estimation of stomatal index- Determination of leaf area of plants, Estimation of transpiration, Estimation of photosynthetic efficiency, Growth analysis – LAI, CGR, LAD etc., Identification of macro nutrients and micro nutrients deficiencies, Measurement of stress tolerance parameters in trees – soluble protein, membrane stability index, chlorophyll stability index, proline content, wax and cuticle thickness, Demonstration of practical applications of PGRs.

Suggested readings

1. Jain, V.K. 2007. Fundamentals of plant physiology, S, Chand and company Ltd., New Delhi.
2. Luttge, U. 2008. Physiological ecology of trophical plants. Springer – Verlag, Germany
3. Lamber, H. Chapin III. F.S and Pons. T.L. 2008 Plant physiological ecology. 2nd edn, Sprinjer, Newyork, USA.
4. Stephen. G. Pallardy. 2008. Physiology of woody plants. 3rd edn, Elsevier Incl. Academic press.
5. Taiz. L. and Zeiger. E., 2010 (fifth edition). Plant physiology. Publishers: Sinauer Associates, Inc., Masachusetts, USA

Plantation Forestry 3 (2+1)

Objective

To acquire knowledge on intensive silvicultural practices for different forest plantations for obtaining higher utilizable biomass

Theory

Plantation - Definition and scope - aims and objectives of Plantation forestry - Historical perspectives in plantation forestry - Indian and global scenario - Role of plantation forestry in meeting the wood demand- purpose of plantations, factors determining scale and rate of plantation. Plantation sites - Choice of species for plantation – Tree species suitable for different sites - Production technology for quality planting materials – Site selection and site preparation – Mechanization in plantation establishment - Planting program, planting season, planting pattern, spacing, planting method. Post planting activities in plantation - Tending operations – Irrigation and nutrient management in plantation – Plantation health management and sanitary measures – Stand dynamics- Stand density management in plantation – Biology of growth and development in plantation. Energy and Industrial plantations – definition and scope - project formulation - planning in plantation - choice of species and spacing - precision silvicultural techniques - Industrial plantation models - captive and agroforestry models. Plantation for specific purpose - timber - paper and pulp - match wood - ply wood - Plantation for NTFPs. High Density Short Rotation Forestry practices - Plantations as potential Carbon sinks- Carbon credits- Afforestation/ reforestation based CDM projects for climate change mitigation. Harvesting in plantation – harvesting types and patterns based on domestic, industrial, and export requirements – Machineries used in harvesting operations – primary conversion at plantation site – Delimbing, bucking, debarking, stacking, *in-situ* chipping, and transportation. Coppice silviculture – principle, mechanisms and management. Economics of plantation – Scale of finance of plantations.

Practical

Study the tools and equipment in plantation establishment – Visits to small and large plantations and study their management - Exercise on plantation project planning, evaluation and appraisal. Choice of species for various types of plantations - Quality planting material for plantations - Layout of site and stacking - Planting and after care activities for different types of plantations - Irrigation and fertilizer application techniques for plantation – Fertilizer and irrigation schedule for various tree species – Tending operations - Study of Forest Development Corporation plantations – Plantation maintenance – Plantation records and plantation journal - Economic considerations in plantation: Preparation of scale of finance for various out growers and plantation schemes - Study of government vs. private plantations.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336.
2. Dwivedi, A.P. 1993. A. Text book of Silviculture, International Book Distributors, Dehra Dun.
3. Luna, R. K. 1989. Plantation Forestry in India. International Book Distributors, Dehradun.
4. Ram Prakash, R. 1998. Plantation and nursery technique of forest trees. International Book Distributors, Dehradun.
5. Evans, J. 1982. Plantation forestry in the tropics: Clarendon Press, Oxford, Oxford Science Publications, Oxford University Press.

Tree Improvement 3 (2+1)

Objective

To develop a balanced and broad understanding of concepts and techniques related to tree breeding and tree improvement strategies

Theory

Tree Breeding – Tree Improvement – History and development. Essential of Tree improvement – Tree Breeding – Objectives – Advantages – Disadvantages – Limitations. Terminologies commonly used in tree improvement – Important tree breeding program in the Global and India – ICFRE and State Agricultural Universities. Introduction – Domestication. World collections – Centre of origin of cultivated species. Exotic forest species – Advantages – Problems. Reproductive systems – Devices of pollination control – Anthesis – Pollination – Self-pollination and cross pollination – Variation and its uses. Breeding methods – Introduction – Selection - Mass selection - Pure line selection – Plus tree selection – Comparison tree selection. Hybridization – Mutation – Biotechnology based tree breeding. Hybrid – Hybridization – Genetic consequences – Gene character – Relationship - Segregation – Recombination of genes. Hybrid vigour – Heterosis – Luxuriance. Tree hybrids developed in Global and India – Natural hybrids – Definition – Occurrence – Reasons determination of natural hybrids. Hybrids in trees – Crossing in trees – Problems and perspectives – Crossing hybrids and hybrid breakdown – Hybrid nomenclature in trees – Future of hybrids in applied tree improvement. Mating design – Types – Advantages and disadvantages. Heritability - Genetic gain – Genetic advance – Combining ability – Types – GCA and SCA. Genetic tests – Provenance test – Seed source evaluation test – Progeny test – Clonal test. Experimental design – RBD – Analysis

of Genetic test – Genotype and environment interaction. Release of tree varieties – Procedure and Protocol – Released tree varieties of regional and national importance. Varietal registration (PPVFRA) – Definition – Breeder's variety – Famer's variety – Traditional variety – Tribal varieties – Essentially derived varieties. Descriptors – development validation. DUS test – Definition, need and importance. Test guide lines –procedures – Conducting DUS test. Tree DUS testing – Development of descriptors for trees – DUS test centers. Recent developments in tree DUS testing.

Practical

Selection for different tree improvement programs – Hybridization – Inter and Intra specific - Evaluation. Controlled breeding – Phenotypic and genotypic coefficients of variation. Estimation of genetic advance – Heritability - Combining ability – GCA and SCA. Genetic tests – Provenance test – Seed source evaluation test – Progeny test – Clonal test. Experimental design – RBD – Analysis of Genetic test. Seed orchards – Genetical behavior in seed orchard. Forest genetic resource – Visit to progeny evaluation genotypes. Developing descriptors for varietal registration in trees.

Suggested Readings

1. Bruce Zobel and John Talbert. 1984. Applied Forest Tree Improvement. John Wiley and Sons, New York. pp504.
2. Parthiban, K.T., N. Krishna Kumar and P.S. Devanand. 2020. Tree Breeding and Improvement – Theory and Technology. Scientific Publishers (India), Jodhpur, India (ISBN No.: 978-93-89412-83-3).
3. Surendran, C., R.N. Sehgal and M. Paramathma. 2003. Forest Tree Breeding. ICAR, New Delhi. P. 204.

Forest Resource Management 2 (1+1)

Objective

1. To understand the principles and concepts of basic forest management, normal forest, sustainable forest management
2. To acquire knowledge on methodology of working plan preparation

Theory

Forest Management - Definition and scope - Management of forests and its peculiarities - Forest management for environmental conservation - Forest management for soil and water conservation - Principles of forest management and their application. Objects of management: Purpose and policy, Objectives, Owner's attitude and social role of forestry. Sustained yield - Concept and meaning of sustained yield - Progressive yield - Sustained yield in relation to environmental management. Sustainable forest management-criteria and indicators - Increasing and progressive yields. Rotation-definitions-various types of rotations length of rotations - choice of type and kind of rotation. Normal forest – Definitions - Basic factors of normality. Factors governing the yield and growth of forest stand. Growing Stock - General considerations - Distribution of age gradations or classes in regular forests, irregular forests and coppice systems. Growth estimation and reduction factors for density and Quality and price increment. Yield regulation - General principles of yield calculation - Silvicultural system in relation to yield regulation. Methods of yield regulation - Yield

regulation in regular forests - By area, reduced area, Hufnagl's modification and By volume and increment methods. Yield regulation in irregular forests - Methods based on growing stock only, Von Mantel's formula and its modifications, Methods based on volume and increment, Austrian method, Method based on number of trees in various age classes and time taken to pass from one age class to next, Brandis method, Hufnagl's method and Smithies safeguard formula. Application of different methods of yield regulations in forest management in Indian forestry. Management (Working) Plan - Definition, object, scope, sphere, necessity for revisions - Division of forests into various units – Maps - Management (Working) Plan Code. Preparation of Management (Working) Plan - Preliminary Management Plan report - Field work - Stock mapping - Checking of maps - Compartment description - Collection of statistical data and other data.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Yield regulation in regular forests and irregular forest. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan. Writing preliminary working plan report and actual working plan report of a given area. New proposal for writing fire management plan.

Suggested Readings

1. Balakathiresan, S. 1986. Essentials of forest management. Natraj Publishers. Dehradun.
2. Negi, S.S. 1988. Forest working plan. B.S.M. Pal Singh, Dehradun
3. Ramprakash, 1986. Forest Management. IBD Distributors, Dehradun

Non-Timber Forest Products 3 (2+1)

Objective

To impart knowledge on various Non-Timber Forest Products and their harvesting, processing, value addition, marketing and industries involved in NTFPs production

Theory

Non-Wood Forest Products – Definition, scope and present status, survey, economic importance, classification, distribution, marketing. Role of tribal co-operative societies in NWFPs. Recent trends in NWFP. Gums: Occurrence – Origin – Functions – Kinds – Properties – Tapping methods – Processing – Grading – Storage – Factors affecting gum formation - Commercial valuation – Industrial application. Resins and Oleoresins: Occurrence – Origin – Functions – Kinds – Properties – Tapping methods – Processing – Grading – Storage – Factors affecting resin and oleoresin formation - Commercial valuation – Industrial application. Grasses: types – Species – Uses. Various grasses and their uses in village and cottage industries. Bamboos – Distribution, harvesting and uses, raw material scenario in bamboos. Canes - Distribution, harvesting, processing and uses. Fibres: species – Types – Soft, hard and surface fibres – Extraction and uses. Flosses: Species – Distribution – Collection – Extraction – Uses. Essential oils: Species – Types – Grass oils, wood oils, leaf oils, root oils, flower oils and minor essential oils. Tree Borne Oil seeds (TBOs): Collection

– Extraction methods – Uses – Value addition. Tan: – Species – Nature and kinds – Occurrence – Function – Collection – Extraction – Uses – Supply and demand. Dyes: Definition – Species – types – Wood dyes – Bark dyes – Flower and fruit dyes – Leaf dyes – Extraction and uses. Cutch and katha: Species – Extraction methods – Uses. Rubber: Cultivation, and tapping – Processing - Uses of rubber. Lac: Species – Distribution – Improved method of cultivation – Collection and storage – Uses. Shellac: Cleaning and grading – Properties – Uses. Drugs, spices, wild edible plants part like fruits, flowers, roots, tubers, vegetables, leaves and edible products, poisons and bio-pesticides. Bidi leaves - Leaf fodder - Animal products – Honey and wax, collection, processing, storage, silk.

Practical

Identification of non-wood forest products; Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and tree leaves. Study of canes and bamboos and their sources. Study of essential oils and their sources. Visit to oil extraction unit Study of non-essential oils and their sources. Study of gums and resins and their collection. Study of tans and Visit to tannin industry; Study of dyes and Visit to dye extraction unit and their sources. Study of fibers, flosses and their collection from nearby forests. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, spices, wild edible plants, poisons and bio-pesticides and their collection from nearby forests. Visit to a tribal village involved in collection, processing and sale of NTFP's. Visit to nearby extraction units and NTFP museum. Visit to forest range office and study about the permits issued and collection methods of various NWFPs.

Suggested Readings

1. FRI (Forest Research Institute). (1976) Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehra Dun. 941p.
2. Krishnamurthi T. (1993) Minor forest products of India, Oxford and IBH Publishing Co Pvt. Ltd.
3. Krishnamurthi T. (2010) Minor forest products of India (Non- Timber Forest Products), Second edition. BS Publications.
4. Mehta, T. (1981) A Handbook of Forest Utilization, Periodical Expert Book Agency.
5. Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004) An Omnibus of Non- Timber Forest Products of India, Prashant Gahlot at Valley Offset Printers and Publishers, Dehra Dun.
6. Nair, K.K.N. (2000) Manual of Non-Wood Forest Produce Plants of Kerala, Kerala Forest Department, Government of Kerala, Thiruvananthapuram.
7. Nautiyal, S and Kaul, A.K. (2003) Non –Timber Forest Products of India, Jyothi- Publishers and Distributors, Dehra Dun.

Forest Pest and Diseases 3 (2+1)

Objective

To impart the knowledge on basic concepts and management of pest and diseases in forest trees

Theory

Insects - Insect Body regions - Position of Insect in Animal Kingdom - Reasons for insect dominance - Insect Systematics - major orders- Categories of pest - IPM definition - Economic

Threshold Level- Economic Injury Level- Components of IPM - Pest Surveillance - Forecasting - Pest management - methods - Silvicultural - Mechanical - Physical - Host Plant Resistance - Biological (Parasitoid, Predators, Microbials) - forest (insects) biological chain - Legal - Chemical - Classification of Insecticides - Chlorinated Hydrocarbons- Organophosphates- Carbamates - Botanicals - Newer molecules (Photostable) -IBPM. Nursery Pests - Pests of Major trees and their management - Teak, Sandal, Sal, Ailanthus, Bamboo, Gmelina, Eucalyptus, Tamarind, Casuarina, Melia, Silk Cotton, Neem, Pungam - Termites - Termite pests of timbers - Dampwood termites - Drywood termites - Subterranean termites - Termites Castes and Management. Forest pathology - Definition - importance –History of forest pathology- Losses due to forest tree diseases- Etiology, symptoms, mode of spread and management practices for teak, sal, sandal, Gmelina, Dalbergia, Silver oak, Hardwickia, Eucalyptus, Casuarina, Bamboo, *Acacia, Ailanthus, Melia dubia*, Neem and Pungam, Chir pine and Blue pine. Disease assessment- IDM in forest trees- pathogens affecting timber, sap and pulpwood in storage - timber decay, white fibrous rot, white pocket rot, dry rot, brown rot - Stains - blue - sap stain - factors determining different wood decay - IDM practices for decay and wood preservation techniques.

Practical

Study of External structure of Insect; Type species - Grasshopper / Cockroach. Methods of Insect Collection, preservation, display and storage. Types of insect Head, antenna, mouthparts, Legs and Wings and Modifications. Major Orders Orthoptera, Thysanoptera, Diptera, Hymenoptera, Coleoptera, Hemiptera, Lepidoptera. Assessment of Insect and mite damage in nursery and plantations. Observing the characters and identification of Pests on Teak, Sandal, Bamboo, Eucalyptus, *Ailanthus*, *Melia*, Casuarina, Tamarind, and Pungam. Insecticide Formulations, Appliances and Applications. Study the symptoms and microscopic observation, Etiology of the diseases of Teak (*Tectona grandis*), Sal (*Shorea robusta*), Sandal, Gmelina, Dalbergia, Silver oak, Hardwickia, Eucalyptus sp., Casuarina sp., Casuarina, Bamboo sp, Ailanthus sp. and *Melia dubia*, Neem, Pungam, Chir pine, Blue pine. Disease assessment in forest trees. Study of fungi infecting timber, sap and pulp wood in storage, wood staining fungi. Study of wood decay and wood preservation technique.

Suggested Readings

1. FRI (Forest Research Institute). (1976) Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
2. Krishnamurthi T. (1993) Minor forest products of India, Oxford and IBH Publishing Co Pvt. Ltd.
3. Krishnamurthi T. (2010) Minor forest products of India (Non- Timber Forest Products), Second edition. BS Publications
4. Mehta, T. (1981) A Handbook of Forest Utilization, Periodical Expert Book Agency.
5. Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004) An Omnibus of Non- Timber Forest Products of India, Prashant Gahlot at Valley Offset Printers and Publishers, Dehra Dun.
6. Nair, K.K.N. (2000) Manual of Non-Wood Forest Produce Plants of Kerala, Kerala Forest Department, Government of Kerala, Thiruvananthapuram.
7. Nautiyal, S and Kaul, A.K. (2003) Non –Timber Forest Products of India, Jyothi- Publishers and Distributors, Dehra Dun.

Wildlife and Protected Area Management 3 (2+1)

Objectives

1. To impart basics, functional and technical knowledge to the students on the various aspects of management strategies of the wildlife in natural ecosystem and captive conditions
2. To acquire knowledge on principles and concepts of habitat management help to understand a challenge/opportunity in a given protected area and also to understand the global protected area system

Theory

Foundation and basics of protected area management - History of the IUCN protected area categories - Purpose of the protected area management categories. Global and Indian status of protected area management. Biogeographic regions of India - Wild animal distribution pattern in India- IUCN Red data book. Habitat requirements of animals – Components of Habitat - Wildlife habitat assessment – Standard evaluation procedure (SEP) - Advancing the successional process and Setting back successional process - Management of protected areas (*In-situ* conservation) - National parks - Sanctuaries – Tiger Reserves – Community reserves – Conservation reserves - Zoning and buffering - Framework for preparing a wildlife management plan. Wildlife census - Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect – Scat analysis – Population viability index (PVI) - Statistical analysis- Software's in wildlife management - Special projects for wildlife conservation – Biotelemetry - Transmitters, receivers, analysis of data, visual tagging and marking- Drone based animal monitoring systems - Role of Camera traps and MSTripES App- Role of Remote Sensing and GIS in Wildlife management. Captive wildlife – Zoos, Biological parks and safari parks - Captive breeding program- Conservation breeding program - Central Zoo Authority of India and its function - Wildlife (Protection) Act, 1972 and its amendments. Role of NGOs in wildlife management. Introduction and reintroduction of species - International conventions MAB, CITES, CMS and CBD. Wildlife corridors -. Human Animal Coexistence- Wildlife Damage - Appraisal, Mitigation measures and Management. Healthcare, Disease Management and Nutrition in Wildlife sanctuaries and National parks, Biosphere reserves and Zoos - Major protected areas of India - Wildlife education - Wildlife tourism.

Practical

Exercise on the census methods - Direct method - Total count, block count, water hole count, capture, mark and recapture method, point transect, and line transect method – Use of software for analysis. Indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife. Study on habitat analysis and evaluation. Studying habitat management and manipulation techniques. Wildlife damage and mitigation measures: Questionnaire survey. Wildlife photography. Wildlife tourism management.

Suggested Readings

1. Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA. International Zoo Books, Published by New York Zoological Society, New York

2. Krebs, C. and Davis, N. 1978. Introduction to behavioral ecology. Oxford University Press
3. Lever, C. 1985. Naturalised mammals of the world. John Wiley, London
4. Mills, L. S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (2nd edn). Wiley-Blackwell.
5. Nigel Dudley. 2013. Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland.
6. Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.
7. Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun
8. Wildlife Institute of India (2004) Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun
9. Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England.
10. Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

Industrial Agroforestry 2 (1+1)

Objective

To develop skill and expertise on Industrial Agroforestry and associated supply and value chain management

Theory

Forests and Agroforestry – Extent of Area - Current status – National and International scenario – Role of Forests in Industrial sector – Industrial raw material – Demand and supply – Indigenous and exotic industrial resources – Policy and legal issues in industrial wood plantations and agroforestry - Major wood-based industries in India – Timber, pulpwood, plywood, panel. match splints, sports and goods, agricultural implements, construction, body building, ship industry, etc. - raw material requirements and procurements – Industrial important NTFPs – Scope and importance - Promotion of industry-based farm and agroforestry – Strategies for promotional activities. Industrial Agroforestry plantations – Status in India – Preferred species – Plantation management and establishment – Precision silvicultural techniques for Timber, pulp and paper, Match, plywood, dendro power– Propagation and plantation techniques – Pest and disease management for major industrial agroforestry tree species. Harvest operation – Mechanization – Yield potential. Value addition – Utilization of plantation and industrial residues – Briquettes and pellets. Supply Chain - Definition – Concept – Supply chain network – Logistic activities – Marketing system – Marketing type and channel – Price patterns of various agroforestry industrial wood products – Contract farming - Definition – Concept and methods of contract farming – Contract tree farming systems in India – Experiences of wood based industries in contract farming – buy back– Corporates in Industrial Agroforestry – International corporate involved in Industrial Agroforestry –Success stories - Corporate social responsibilities – Tree Insurance Scheme (TIS) – Felling regulatory mechanism. Consortium of Industrial Agroforestry – TNAU Model for sustaining industrial agroforestry - Agroforestry business innovations and entrepreneurship development - Agroforestry based business incubation opportunities. Impact of Industrial Agroforestry – Economic and Ecological impacts: Climatic, edaphic and biotic– Carbon sequestration – Carbon storage potential of Industrial Agroforestry and carbon trading mechanism of Industrial Agroforestry – Socio-economic impacts – Rural livelihood improvement and economic return – Environmental impact.

Practical

Study of various wood based industries – Preferred species (State specific) – Timber agroforestry -Pulp and paper based agroforestry– Plywood based agroforestry – Matchwood based agroforestry – Dendro energy agroforestry – NTFPs agroforestry - Plantation management – Harvest and mechanization – Value addition Technology – Contract tree farming – Economics – Bankable project preparation - Visit to wood and non-wood based industries – Exposure to Business opportunities –DPR preparation for industrial agroforestry based business model.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336.
2. Parthiban, K.T., R. Umarani, S. Umesh Kanna, I. Sekar, P. Rajendran and P. Durairasu. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
3. Parthiban, K.T. and R. Seenivasan. 2017. Forestry Technologies- A complete Value Chain Approach. Scientific Publishers, Jodhpur. p 629.
4. Parthiban, K.T. and Keerthika, A. 2020. Textbook on Agroforestry – Principles, practices and Applications. Agrobios, Jodhpur, p256

Study Tour — 2 (0+2) Non-Gradial

- To be conducted for 10-12 days during 5th semester.
- The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organisations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ states and the social and cultural differences existing in the country.
- After the visit, the students will be submitting a report/ make a presentation.

Semester VI

Forest Biotechnology — 3 (2+1)

Objective

To educate on the principles, tools, possibilities and progress made in biotechnology

Theory

Basics of Plant Tissue Culture Plant tissue culture: Concepts, history and scope – Components of Media and their role; Sterilization techniques ,Culture Conditions and Factors affecting *in vitro* cultures; Regeneration methods - morphogenesis, organogenesis and embryogenesis; Techniques in plant tissue culture - Micropropagation, meristem tip culture, another culture, pollen culture, ovule culture, embryo culture, callus culture and suspension culture; Somatic embryogenesis and synthetic seed production; Protoplast isolation, fusion and cybrids applications in crop improvement; Soma clonal variation, types, causes and applications; Secondary metabolite production and *in vitro* germplasm conservation ; National certification and Quality management of TC plants. Biotechnology- Definition, History and scope. Importance of biotechnology in Crop improvement.

Genome organization. Structure of nucleic acids-Concept of gene and gene architecture. Central Dogma of molecular biology. Overview of DNA replication, transcription and translation. Regulation of gene expression. Basic techniques in molecular biology-Blotting techniques-Polymerase chain reaction- DNA sequencing methods. DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases - Different types of vectors: plasmids, phagemids, cosmids, BAC,YAC,PAC, Expression, Shuttle, binary and co-integrate vectors - Construction of recombinant DNA molecules- Bacterial transformation - Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, *Agrobacterium* mediated method - Tissue specific promoters, selectable and scorable markers, reporter genes- Molecular analysis of transgenic plants – Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality- Detection of GMOs – regulations and biosafety. DNA markers - hybridization based markers (RFLP) - PCR based markers: RAPD, SSR, SCAR, AFLP, STS and SNPs - DNA fingerprinting of crop varieties – Development of mapping populations-linkage and QTL analysis- principles, methods and applications of Marker Assisted Selection in crop improvement; Applications of Plant Genomics and genome databases. Micropropagation in forest trees – successful examples – bamboo, sandal wood, eucalyptus, Paulownia and Melia. Bioprospecting industrially useful compounds from forest trees. Application of genetic engineering in forestry sciences –Molecular markers and its applications in forestry, Lignocellulose degrading microorganisms, Cellulose gene in tree species.

Practical

Biotechnology Laboratory organization - safety regulations-Sterilization techniques for aseptic manipulation-Calculations in Biotechnology and preparation of plant nutrient stock solutions-Preparation of plant nutrient medium -Shoot Tip Culture, Meristem Tip Culture, Anther and embryo culture, Callus culture and suspension culture -Hardening and acclimation of *in vitro* regenerated plants. Isolation of bacterial plasmid DNA - Agarose Gel Electrophoresis - Gene cloning and Bacterial transformation-Genomic DNA extraction - Quantification of DNA and quality check- Plant genetic transformation- biolistic and *Agrobacterium* mediated transformation-DNA amplification using PCR -NTSys- Analysis of Diversity in Crop Plants- Visit to a Plant Biotechnology Lab /Commercial Plant Tissue Culture facility.

Suggested Readings

1. Brown, T. A. 2010. Gene Cloning and DNA Analysis: An Introduction, 6th edn, Wiley-Blackwell Companion site
2. Krebs, J.E, Goldstein, E.S, Kilpatrick, S.T. 2017. Lewin's Genes XII. Jones and Bartlett Publishers, Inc., p.838
3. Malacinski, GM (2015) Freifelder's Essentials of Molecular Biology (4th Student edn) Jones and Bartlett Publishers, Inc.
4. Nelson D.L and M.M. Cox. 2017. Lehninger Principles of Biochemistry, (7th edn) W. H. Freeman and Company, New York, USA. p.1328.
5. George, E. F., Hall, M. A. and De Klerk, G. J. (Eds), Plant propagation by tissue culture. Volume 1. The background. 3rd edn. Springer, 2008, 501 p, ISBN 978-1-4020-5004-6.
6. Stewart, Neal Jr. C. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications John Wiley and Sons, Inc ISBN: 978-0-470-04381-3.

7. Singh, B.D. 2012. Plant Biotechnology. Kalyani publishers, Ludhiana.
8. Tomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. Molecular markers and Plant Biotechnology, New Publishers, New Delhi.

Forest Economics and Marketing 2 (1+1)

Objective

To give exposure to the students on market concepts, marketing of forestry commodities, intermediaries involved, risks in forestry marketing, marketing institutions involved, price dynamics and the role of Government in regulation of markets

Theory

Economics - Definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Forest economics - Definition, characteristics of Forestry sector and its role in economic development. National Income – Definition and concepts: Gross National Product and Gross Domestic Product. Consumption - Utility and its measurement: Cardinal and Ordinal. Theory of consumer behavior – Law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Demand – Law of Demand - Elasticity of demand – Types of elasticity of demand - Importance of elasticity of demand. Engel's law of family expenditure. Consumer surplus. Theory of firm, concept of production, factors of production – Land and its characteristics, labour and division of labour and theories of population. Capital and its characteristics. Enterprises - Factor – Product relationship. Laws of returns – Law of diminishing marginal return – Law of supply – Distribution. Exchange: Marketing – Role of marketing – Marketing functions – Producer surplus – Marketable and Marketed surplus – Marketing channels of forest products – Price spread – Marketing Efficiency – Integration – Market intelligence. Market equilibrium, Price determination and forecasting under various market structures. Basic guidelines for preparation of project reports – Bank norms and Farm Financial Analysis – Crop Insurance – SWOT analysis – Crisis management. International Trade: Concept of International Trade - Free trade, Autarky and it needs - Absolute and Comparative advantage; present status and prospects of exports / imports - Role of institutions like APEDA, MPEDA, ITTO, UNCTAD and GATT – WTO. Free Trade Agreements – AoA and its implications on Indian agriculture.

Practical

Estimation of consumer's equilibrium – Cardinal and Ordinal Utility Approaches. Plotting and study of demand and supply curves and calculation of elasticities of demand and supply. Study on law of diminishing marginal return. Estimation of Optimal input and Output levels. Estimation of cost of cultivation and cost of production for forest products. Preparation of Bankable projects for forestry products and its value added products. Estimation of farm financial ratios. Computation of marketable and marketed surplus of important commodities, Identification of marketing channel of Agriculture / Horticulture / Forest products – Calculation of Price Spread – Identification of Market Structure – Time series analysis of prices - TCSI. Index number construction and uses. Visit to wood depot/LAMPS/Co-operative marketing society/ Farmers' Markets. Visit to Commercial / Co-operative Bank. Visit to different markets and processing units of Forest products.

Suggested Readings

1. Acharya S.S. and Agarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH Publishers, New Delhi
2. Chadra P. 1984. Projects: Preparation, Appraisal and Implementation, McGraw Hill Inc.
3. Charya SS and Agarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH Publishers, New Delhi.
4. Dewett K. K. 2005. Modern Economic Theory. S. Chand and Company, New Delhi.
5. Dewett K. K., Verma. 2004. Elementary Economic Theory, S. Chand, New Delhi.
6. Jhingan M. L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi.
7. Reddy S.S., Raghu Ram P., Neelakanta Sastry T.V. and Bhavani D.I. 2004. Agricultural Economics. Oxford and IBH Publishers, New Delhi.

Watershed Planning and Management 2 (1+1)

Objective

To teach the students on different aspects of hydrology and watershed management and to impart basic knowledge on various measures of soil and water conservation

Theory

Introduction – Hydrology and its importance in forestry. Hydrologic cycle. Precipitation – forms. Rainfall – types. Intensity, duration and frequency. Infiltration, percolation, evaporation, transpiration and evapotranspiration. Runoff - runoff process – factors affecting runoff - prediction and estimation of runoff. Hydrograph – unit hydrograph. Sedimentation and stream gauging. Soil erosion – Principles - types of erosion - geological and accelerated. Forms of erosion - water erosion - kinds and forms - causes and effects - degree of erosion. Wind erosion – types – saltation, suspension, surface creep. Control of wind erosion - shelter belts and wind breaks. Sand dune stabilization. Land capability classification - recommended land use. Soil and water conservation - historical review – its need. Biological measures – afforestation, contour farming, strip cropping, cropping systems as inter cropping, crop rotation and mixed cropping, mulching and tillage practices. Grassland management. Mechanical measures - Contour bunds, Graded bunds, Bench terracing and Stone wall - Design of structures for soil conservation. Erosion control measures for non-agricultural lands, Soil conservation on Wastelands - contour and staggered trenching. Gully control structures - Temporary and permanent –check dams – types. Spillways – drop and chute spillways, drop inlet. Water Harvesting – definition, methods and techniques - treatment of catchments. Water Harvesting for Trees and Shrubs. Ground water – Aquifer – water harvesting for ground water recharge. Storage structures – Ponds – types. Watershed Management – definitions. Characteristics of watershed - elements and components. Selection of Priority areas - Planning and implementation of watershed programs in forest watersheds. Watershed work plan. Monitoring and evaluation of watershed programs. Remote sensing and GIS in watershed management.

Practical

Computation of mean rainfall – Isohyet and Thiessen polygon methods. Determination of infiltration with double ring infiltrometer. Estimation of runoff. Erosion estimation – Problems

on USLE. Design of shelterbelts and windbreaks. Design of contour bunds, stone wall and bench terraces. Design of check dams. Visit to erosion prone and watershed areas. Design of water harvesting systems – roof water harvesting and percolation ponds. Design of micro catchment water harvesting systems for trees. Visit to soil conservation sites and silt monitoring station. Exercises on Demarcation of watershed. Preparation of watershed plan - monitoring and evaluation of watershed programs.

Suggested Readings

1. Das, Ghanshyam. 2009. Hydrology and Soil Conservation Engineering. PHI Publishers, New Delhi.
2. Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
3. Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
4. Oswal, M.C. 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
5. Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
6. Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
7. Suresh, R. 2000. Soil and Water Conservation Engineering. Standard Publishers, New Delhi.

Forest Tribology, Ethno-medicine and Extension 3 (2+1)

Objective

To impart basic knowledge on local indigenous peoples their knowledge on ethno medicines and the extension skills and knowledge with reference to forestry

Theory

Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare. Ethno- medicines of tribals in Southern India. Traditional Botanical Knowledge. Ethno- medicines of the plants from the following families. Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpiniaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae and Thymeliaceae. Introduction- human behaviour and psychology. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Types of education, Formal, informal non-formal education. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programs like RD, OFT, FLD, KVKs – AKIS (Agricultural Information System), ATMA – ICT enable extension

services. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Diffusion and adoption process. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group, classification of group.

Practical

Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/Mahila Mandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing). Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards. Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises. Field visit to Different tribal regions to gain ethnobotanical knowledge and the interrelation between plant and people - Survey and identification of plants used by the tribals for medicine, food and other social purposes - Collection and preparation of herbarium specimens of the above plants.

Suggested Readings

1. FAO. 1984. Forestry extension, making it works, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
2. Furer-Haimendorf, C.V. 1985. Tribes of India - the struggle for survival. OUP. New Delhi
3. Hasnain, N. 2007. Tribal India. New Royal Book Company
4. K.A. Jalihal and V. Veerabhadraiah. 2007. Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.
5. L.K. Jha and P. K. Sen Sarma, A.P.H. 2008. A Manual of Forestry Extension Education, Published by VEDAMS, P. 386 p.
6. Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672 p.
7. Sharma, R.N. and Bakshi, S. 1984. Tribes and tribal development. Uppal Publ. House, New Delhi.
8. Sim, D. and Hilmi, H. A.1987. Forestry Extension Methods, FAO Forestry Paper-80, P. 153.
9. Thakur, D. 1986. Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi
10. Vidyarthi, L.P. and Rai, B.K. 1985. The tribal culture of India. Concept Publ. Co., New Delhi.

Remote Sensing and GIS 2 (1+1)

Objective

To inculcate students regarding the concept of Remote sensing and GIS tools in forestry sector

Theory

Definition, scope, history and development of remote sensing; Electromagnetic radiation (EMR) and electromagnetic spectrum; EMR interaction with atmosphere and earth surface; Types

of remote sensing; Principles and applications of optical, thermal and microwave remote sensing; Aerial photographs – types, scale, and resolution; Photo interpretation, Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Program. Different concepts of RS. Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery; Forest cover monitoring and Forest fire damage assessment; Microwave remote sensing. Studies of different vegetation indices like NDVI. Wild life assessment. Introduction to GIS - Components of GIS, Hardwares and software's; Differences between GIS and conventional cartography; Spatial and non-spatial data, Integration of attribute data with spatial data. Spatial data - Raster and Vector data. Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection, Topo sheet and Map reading; Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, IRNSS.

Practical

Preparation of base maps, thematic maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping; Digital image processing; Introduction to various GIS and RS software; Exercises in viewing, editing, overlay. Visit to the RS and GIS labs at State level. Using of QGIS Software to prepare different maps.

Suggested Readings

1. Curran, P.J. 1985. Principles of Remote Sensing, Long man Group Ltd., England.
2. Janssen, L.F.2000. Principles of Remote Sensing. ITC. Edl. Text Book Series II. The Netherlands.
3. Rolf A.de by. 2000. Principles of Geographical Information Systems. ITC. Edl. Text Book Series I. The Netherlands.
4. Sabins, F.F.1978. Remote Sensing-Principles and Interpretation. W.H. Freeman and Co. San Francisco.
5. Sharma, M.K.1986. Remote Sensing and Forest Surveys, International Book Distributors, Dehra Dun.
6. Sharma, S. and Dey, S. K. 2021. Entrepreneurship Development and Business Ethics. V.K. Global Pvt. Ltd., New Delhi.

Forest Business Management 2 (1+1)

Objective

To understand the concept of forest business management and steps to start and manage the forest based business

Theory

Management – Definition – Importance of Management – Evolution of Management thoughts - Management functions – Nature of management functions – Management Roles – Functions at various levels of Management – Management skills. Forest Business Management – Definition, Scope, Importance and Characteristics of Forest Business Management -. Special features of Forest Business – Classification of Enterprises-Micro, Small, Medium and Large. Forms of Business Organisations – Sole Proprietorship – Partnership –Private and Public Limited - Business environment – Micro

and Macro environment - Startup and Business incubators. Planning – Concept – Nature – Types of Planning – Importance of Planning - Plans-Types of plans –Steps in planning - Organising – Concept of Organising - Departmentation – Basis of Departmentation – Span of control Co-ordination -– Types and Techniques. Staffing – Concept – Human Resource Planning – Process. Recruitment and Selection - Training – Concepts – Methods – Evaluation. Directing – Concept – Principles – Techniques – Supervision. Controlling – Concept – Types. Operations Management – Meaning and Scope, Supply Chain Management – Drivers and flows– Meaning and Principles, Marketing Management – Market Segmentation and Marketing Mix Financial Management – Meaning, Objectives and Scope.

Practical

Assessment of entrepreneurial traits-Identification of new business opportunities-Exercise on SWOC Analysis of Agribusiness Sector in India -Market survey for understanding customer needs-Starting new business - Visit to firms / discussion with entrepreneurs-Documenting Procedure for Establishing Agribusiness Firms-Government programs and institutions for entrepreneurship development-Financing new agribusiness ventures - Visit to banks / discussion-Exercise on Demand Forecasting for Agricultural Inputs/Products - Preparation of Advertisement and Sales Promotion Measures for Agribusiness - Exercise on Inventory Management – ABC Analysis and EOQ Model-Exercise on discounted measures of Capital Budgeting-Calculation of Break Even Point and its Business Implication-Understanding balance sheet and income statement-Financial Performance Analysis - Ratio Analysis.

Suggested Readings

1. Girish B and S S Inamati. Forest Business Management by Shahapurmath. Satish Serial Publishing House
2. Koontz. H and Weihrich, H, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
3. Charles W L Hill and Steven L McShane, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
4. Massie, J.L, 1995, Essentials of Management, Prentice Hall of India Pvt. Ltd., New Delhi. Prasad, L.M, 2005, Principles and Practices of Management, Sultan Chand and Sons Educational Publishers, New Delhi.
5. Rao, V.S.B, and P.S. Narayana, 2004, Principles and Practices of Management, Konark Publishing Pvt. Ltd. New Delhi.

Forest Landscape Restoration (FLR) 2 (2+0)

Objective

To develop students' in-depth understanding of forest landscape restoration through both traditional and modern technology

Theory

Definition, Scope and Objectives of FLR – Role of FLR in national, regional and global commitments – Land Capability Classification and Forest Cover Classification. Need for forest restoration programs. Principles and Guiding Elements. Diverse Knowledge Systems in Forest

Landscape Restoration – Social-Ecological Systems and Forest Landscape Restoration - Integrated Landscape Approaches to Forest Restoration. Landscape Ecology - Scope of landscape ecology - Spatial statistics in landscape ecology - Landscape disturbance - Organisms and landscape pattern - Ecosystems processes on landscapes - Land use planning and conservation - Landscape Ecology's contribution to Forest Landscape Restoration. Different Techniques for Forest Restoration – Broad-Scale Traditional Restoration of Landscape techniques – Reforestation with Timber and other woods, Invasive Species Management, Restoring Historic Groundwater Levels and restoration with carbon efficiency trees. Integration of Traditional and Western Knowledge in Forest Landscape Restoration. Restoration to conserve and increase biodiversity - Achieve Climate Goals - Achieve the Sustainable Development Goal - Spiritual and Social Renewal. Linking forest conservation and food security through agroecology: Insights for Forest Landscape Restoration. Integration for Forest Landscape Restoration Implementation. Stakeholders and Forest Landscape Restoration - Tenure, Property Rights and Forest Landscape Restoration - Polycentric Governance and FLR: Governance process versus governance outcome, Formal and informal governance and Re-scaling, mapping and contextualizing.

Suggested Readings

1. Erbaugh, J. T., and Oldekop, J. A. (2018). Forest landscape restoration for livelihoods and well-being. Current Opinion in Environmental Sustainability, 32, 76-83.
2. Lamb, D., Stanturf, J., and Madsen, P. (2012). What is forest landscape restoration? *Forest landscape restoration: integrating natural and social sciences*, 3-23.
3. Maginnis, S., Rietbergen-McCracken, J., and Sarre, A. (Eds). (2012). The forest landscape restoration handbook. Routledge.
4. Mansourian, S., Vallauri, D., Dudley, N., Dudley, N., Mansourian, S., and Vallauri, D. (2005). Forest landscape restoration in context. Forest restoration in landscapes: Beyond planting trees, 3-7.
5. Schultz, C. A., Jedd, T., and Beam, R. D. (2012). The Collaborative Forest Landscape Restoration Program: a history and overview of the first projects. Journal of Forestry, 110(7), 381-391.
6. Stanturf, J. A., and Mansourian, S. (2020). Forest landscape restoration: state of play. Royal Society open science, 7(12), 201218.
7. Chaturvedi, R., Duraisami, M., Jayahari, K. M., Kanchana, C. B., Singh, R., Segarin, S., and Rajagopal, P. (2018). Restoration opportunities atlas of India. Washington, DC: World Resources Institute. Retrieved November, 10, 2019.
8. Singh, R., Shelar, K., Chaturvedi, R., Duraisami, M., andGautam, R. S. (2020). Restoring Landscapes in India for Climate and Communities.
9. ITTO. (2020). Guidelines for forest landscape restoration in the tropics. ITTO Policy Development Series No. 24.

Forest Biomass Energy and Biofuels 2 (1+1)

Objectives

1. To expose the graduating scholars on the existing challenges in energy sector
2. To create skill and expertise on the need for forest-based bioenergy and biofuel towards creating self-reliance in raw material besides combating the climate change risks and uncertainties

Theory

Energy status in India – demand for electricity –energy generation from various sources- Coal demand and supply-demand for liquid fuels –Petrol and diesel - Need for alternate energy resources – forest biomass and biofuel as an alternate- Government initiatives and policies - National Policy on Biofuels (2018) - National Policy on Biofuels (2018) Amendment, 2022. Indian scenario – biomass availability - types of biomasses – Agricultural residues - Short Gestation non-edible oil rich crops - Algal feedstock - Non- Edible Oilseeds (TBOs) - Used Cooking Oil (UCO) - Animal tallow – Acid oils - Current challenges and constraints. Forest-based biomass and biofuels.

Introduction - scope and potential of dendro energy in India – Dendro biomass: composition, sources, benefits - biomass properties of dendro energy species. Potential dendro energy species – cultivation technology - plantation models – High density energy plantation (HDEP). Harvesting of biomass – hrvesting methods – plantation residues - value addition technology - biomass briquettes, pellets and biocoal. TBOs for biofuels - Introduction and scope - International Scenario - Indian Scenario – Current availability and potential of TBOs-Properties of TBOs - Major TBOs in India – *Jatropha curcas*, *Pongamia pinnata - Azadirachta indica - Calophyllum inophyllum - Madhuca latifolia, Simorouba glauca* - Other TBOs – Plantation technologies for major TBOs– Value chain on TBOs – marketing potential of TBOs.

Forest biomass - Biomass based power production methods – Pyrolysis - Gasification – Combustion - TBO based biofuels - oil extraction methods - transesterification for biodiesel production -SAF Production process through TBO - Hydroprocessing of Esters and Fatty Acids (HEFA) process – quality characteristics of biodiesel and SAF.

Practical

Dendro energy resources – study of different tree species – short, medium and long duration- QPM Production technology for energy species- Wood and biomass quality characterization – physical and chemical properties - Wood and biomass quality characterization – thermo chemical properties - Study of energy plantation models – block, agroforestry, farmforestry, linear, multi functional, etc - Primary conversion technology for biomass – biomass – converted woods – chips – various sizes and grades – visit to an industry - Study of dendro energy generation technology – pyrolysis, gasification – visit to a gasification unit - Visit to thermal power plants/ biomass combustion plant – study of energy generaion through combustion and co-firing process - Study of biofuel crops - TBOs – *Jatropha curcas*, *Pongamia pinnata - Azadirachta indica - Calophyllum inophyllum - Madhuca latifolia, Simorouba glauca* - Nursery production technology for TBOs - Plantation production technology for TBOs - block, agroforestry, farmforestry, linear, multi functional, etc - Study of seed collection, storage and processing of TBOs- Oil quality characterization of various TBOs – laboratory analysis - Visit to oil processing centre – study of oil production and by-products - Study of biodiesel production tecnology – transesterification and by-products - Study of SAF – properties.

Suggested Readings

1. Adams P, Bridgwater T, Langton L A, Ross A and Watson I. 2018. Biomass Conversion Technologies. *Greenhouse Gas Balances of Bioenergy Systems.* p134 (ISBN: 9780081010365).
2. Bajpai P. 2020. Biomass to Energy Conversion Technologies -The Road to Commercialization. *Elsevier*. P 204. (ISBN: 978-0-12-818400-4).

3. Hakem K R, Jawaid M and Rashid U. 2014. Biomass and Bioenergy - Processing and properties. *Springer.* P343. (ISBN : 978-3-319-07641-6).
4. Pande M and Bhaskarwar A N. 2012. Biomass conversion to Energy - The Interface of Biotechnology, Chemistry and Materials Science. Springer. p.468. (ISBN: 978-3-642-28418-2).
5. Parthiban K.T. and R. Seenivasan. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publisher. Jodhpur. p.629 (ISBN: 978-93-86102-60-7).
6. Parthiban, K. T., Kumar, N. Krishna; Palanikumaran, B.; Kanna, S. Umesh. Dendro biomass resources for solid and liquid fuel generation - Opportunities and challenges. Authors Madras Agricultural Journal, 2020, p30.
7. Paramathma M, Parthiban, K.T. and Neelakantan, K.S. Strategies for improvement and utilization of Tree Borne oil seeds. 2004. Forest College and Research Institute, TNAU, Mettupalayam. p.218.
8. Radhakrishna. P. 2003. Tree Borne oil seeds as a source of energy for decentralised planning. Renewable energy science series XII. Government of India. Ministry of non-conventional energy sources, Regional office, Chennai.
9. Venkata R P and Srinivas S N .1996. Biomass Energy Systems. *Tata Energy Research Institute*. p345 -87(ISBN: 81-85419-25-6).

Trees Outside Forests 2 (2+0)

Objectives

1. To expose students to the growing importance of trees outside forests
2. To make student understand the need of augmenting tree cover towards meeting the domestic and industrial wood requirement
3. To expose students to the existing technologies, models, policies and other government schemes

Theory

Trees Outside Forests (TOF) – introduction –classification-based on Land use – Trees with Settlements- Trees with Agricultural Lands–Trees along Manmade or Natural Features–based on Geometrical Formation - Isolated and scattered trees - Zonal Trees - Methodology of Assessment by FSI - Stratified random sampling design - Multistage stratified sampling design – Status of TOF in India - State wise TOF status and opportunities – demand and supply pattern of wood and non-wood requirements - Government policies to promote TOF – National Forest Policy (1988), National Agroforestry Policy (2014). TOF- Regeneration, restoration and rehabilitation opportunities and methods– Quality Planting Material (QPM)- Principles and criteria - design and development - General Quality Standards for Nurseries and Plants Produced - Hi-tech Nursery - Design and Development – Components and characteristics - Choice of species – utility based – general plantation techniques for prioritized species –Market and industrial linkages – timber and NTFPs –economically important tree species – various models for TOF –Agroforestry – Farm forestry - Linear plantations- windbreaks-shelterbelts -boundary plantations- riverbank plantations - trees on pasture lands- green cities- urban green space – micro forests– Impacts of TOF – contribution to Forest cover - Restoration of degraded lands – ecosystem services – Provisional – Regulating – Cultural – Supporting.

Timber products – Global status- National status- Saw logs and veneer logs- Pulpwood - Ply and panel- Industrial round wood - Non-timber products- Global status and National status- Gums- Resins- Latex – Dammar – Tannins - Fibres- Floss - Market size -Demand and supply - Processing technology- Value addition- Government regulations- Trade channels-Organizations involved -TOF based TBE opportunities – Production – processing – marketing – value addition-based business enterprises – creation of startups – MSMEs – Business incubation. TOF certification - schemes – scope and opportunities – International certification agencies - certification Institution and organization - FSC certification - PEFC certification - Sustainable Forestry initiative (SFI) – Indian Forest and Wood Certification Council (IFWCC) - NCCF - Quality Planting Material – Government Initiatives- Carbon sequestration potential- UNFCC - Kyoto protocol- COP - carbon credit – International and national status - TOF based carbon trading opportunities -Types of carbon markets – Methodology - Benefits to farmers – Circular economy from TOF based products- Significance of TOF in achieving SDGs and NDCs.

TOF related Schemes and Programs - National Bamboo Mission –Submission on Agroforestry- Green highways missions - Mission for integrated development of horticulture -Nagar Van Yojana (NVY) -National Mission for a Green India (GIM) - USAID funded project on TOFI – objectives, activities and partner institution - participating states – innovative platform – tree out growers schemes-NITI Aayog: Greening and Restoration of Wastelands with Agroforestry (G.R.O.W)- National Mission on Oilseeds and Oil Palm (NMOOP): Mini Mission - III (TBOs).

Suggested Readings

1. Parthiban, K.T. and A. Keerthika. 2020. A textbook of Agroforestry: Principles, Practices and Applications. AgroBios (India), Jodhpur. P. 256 (ISBN: 978-81-973776-8-9).
2. Parthiban, K.T. and R. Seenivasan. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publisher. Jodhpur. P.629 (ISBN: 978-93-86102-60-7).
3. Parthiban, K.T., R. Jude Sudhagar, C. Cinthia Fernandaz and K.K. Suresh. 2018. Agroforestry strategies for climate change (Mitigation and adaptation). Jaya Publishing House, New Delhi. P. 395 (ISBN:978-93-86110-53-4).
4. Atyi E and Simmula, M. 2002. Forest certification: pending challenges for tropical timber. Background paper prepared for the ITTO International workshop on comparability and equivalence of forest certification schemes. Kuala Lumpur. April 3- 4, 2002.
5. Indian Forest and Wood Certification Scheme – Guidelines. Program for Recognition and Accreditation of Sustainable Management Practices for Agroforestry and Natural Forestry Resources. Ministry of Environment, Forest and Climate Change Government of India. P.76
6. NITI Aayog. Technical Report on Greening and Restoration of Wastelands with Agroforestry. (G.R.O.W). 2024.p.96. (ISBN No. 978-81-956821-3-3)
7. Pandey, D. 2008. Trees Outside the Forest (TOF) resources in India. *The International forestry review*, vol. 10, no. 2, pp. 125–33. *JSTOR*, http://www.jstor.org/ stable/43740329. Accessed 17 Apr. 2024.
8. Hegde, N.G. 1991. Agroforestry in India: Scope and Strategies. Agroforestry in Asia and Pacific. RAPA publication:1991/5 Regional Office for Asia and the Pacific. FAO. Bangkok. 47-63 pp.
9. ICFRE (Indian Council of Forestry Research and Education). 2023. Forestry Statistics India 2023. Directorate of Statistics. New Forest. Dehradun. 200 pp.

10. Rudolph S and Aydos E. 2021. Carbon Markets Around the Globe. Sustainability and Political Feasibility. Elgar online. (ISBN: 978-18-391090-8-9).

11. Duraisami M, Singh R and Chalia S. 2022. Roadmap for Scaling Trees outside Forests in India: Learning from select States on Policy Incentives, Enabling Conditions, and Barriers. Working Paper. Mumbai: World Resources India. Available online at https://www.wri.org/research/roadmap-scaling-trees-outside-forests-india.

12. Parthiban K.T, Subbalakshmi V, Jawahar Vishnu M.V and Dabbas M. 2024. A textbook on Trees outside Forests. *Scientific publisher*. Jodhpur (In Press).

Semester VII (Elective Courses)

The student will choose one Elective group among the four major disciplines with a total of 20 credits

S. No.	Course category	Credit Hours
1.	Plantation Forestry	20
2.	Multi-Functional Agroforestry	20
3.	High Yielding Short Rotation Forestry	20
4.	Forest Product Development and Utilization	20
5.	Forest Resource Management and Utilization	20
	Total	**20**

Semester VIII

S. No.	Course Title	Credit Hours
1.	Internship/ Project / Students READY Program	20 (0+20)
	Total	**20 (0+20)**

Training attachment in wood-based industry/ forest departments/ Police/ Special Task Force (STF)/ incubation centres/ KVKs or research Institutes/ NGO/ agribusiness entrepreneur, etc. (May be conducted in split manner in more than one industry/ institution/ organization). Ideally it is recommended to have Internship with Forest Department (Administrative Skill) for 5 weeks, Internship with wood-based industries (Technical Skill) for 2 weeks, Internship with Police/ Special Task Force (STF) for Jungle survival for 1 week and Internship with incubation centres/KVKs for 2 weeks. Either project (R and D based, field study based) or entrepreneurship based (incubation/ experiential learning).

ELECTIVE COURSES

Courses under each major discipline

A) Plantation forestry

1. Commercial tree seedling production (1+2)
2. Commercial plantation development and management (2+1)
3. Forest growth modelling (1+1)

4. Marketing and certification of wood products (1+1)
5. Restoration of degraded lands (2+1)
6. Dendro-biomass and energy plantation (2+1)
7. Plantation and climate change mitigation (2+0)
8. Plant Biochemistry (1+1)
9. Research Methodology (1+1)
10. Statistical Packages for Data Analysis (0+1)
11. Internship with forest plantations-based institutions/plantation companies (0+2).

Commercial Tree Seedling Production **3 (1+2)**

Objective

To impart knowledge on seed collection, tree seedling production through the natural as well as artificial regeneration techniques

Theory

Introduction and scope for nursery technology. Nursery establishment-site selection – planning, and layout of nursery area. Types of nursery, types of nursery beds, preparation of beds, fumigation. Pre- sowing treatments. Methods of seed sowing and mulching, seed size and position of sowing, seedling growth and development, pricking, watering methods, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Containerised nursery technique – advantages, disadvantages – root deformations- container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages, conditions/practices affecting early survival and early growth. Methods for field handling and planting bare-root stock. Containerised nursery Technique-Type and size of containers. Merits and demerits of containerized nursery. Root trainer techniques Preparation of ingredient mixture. Nursery practices that influence seedling uniformity, diameter/height and size of root system. Stump preparation. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept. Temporary and permanent nursery development- preparation of proposal, layout, economic Considerations-Implementation-Emerging trends in forest tree propagation and nursery technology, VMG: Vegetative multiplication garden.

Practical

Raising of stocks, practicing grafting, budding and layering techniques in tree species-anatomical studies of graft and bud joints – studies on cell differentiation and union-studies on treatment effect and pre curing of scion, growth regulator effect on asexual methods – raising nurseries, practicing seed propagation, taking observations, visit of commercial nurseries. Preparation of production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium, and large sized seeds. Mother bed and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery

management operations. Preparation of ingredient mixture. Filling of containers Study of vegetative techniques-cutting, grafting etc. Visit to tissue culture laboratory and other nurseries Temporary and permanent nursery development preparation of proposal, layout, economic considerations.

Suggested Readings

1. Bewely, J.D. and Black, M. 1985. Seed physiology of development and germination.
2. Bose, T.K., Mitra, S.K. and Sadhu, M.K. 1986 Propagation of tropical and sub-tropical. Crops. Naya Prakash, Calcutta
3. Duryea, M.L. and Landis, T. D. (eds.) 1984. Forest Nursery Manual: Production of Bare root Seedlings. Dr. W. Junk Publishers, The Hague/Boston/Lancaster for Forest Research Laboratory, Oregon State University, Corvallis, 386 p.
4. Evans, J. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Claredon Press.
5. Liegel, L.H. and Venator, R. 1987. A Technical Guide for Forest Nursery Management in the Carribean and Latin America. Gen. Tech. Rep. SO-67, New Orleans, LA: U.S. Department of Agriculture.
6. May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. 1985. Southern Pine Nursery Handbook, USDA Forest Service, Southern Region, Cooperative Forestry Mehta, A.R and Bhatt, P.N. 1990. Hand book of plant tissue and all cultures. Academic book centre, Ahmedabad
7. Napier and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal UK Forestry Research Prakash, R. 1990. Propagation Practices of Important Indian Trees. International Book Distributors, Dehra Dun. Project, Kathmandu Oxford. 472p.

Commercial Plantation Development and Management 3(1+2)

Objective

To acquaint students with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations

Theory

Role of plantation forestry in meeting the wood demand - Plantation forestry in India and abroad. Production technology for quality planting stock - preliminary site preparation for establishing plantation - Enrichment of site - Planting program - time of planting - planting pattern - spacing - planting methods. Precision silviculture - concept - advantages of precision silviculture. Tree management - canopy, root and stem engineering. Fertigation system - drip irrigation management for short and long rotation tree species. Fertilizer management for plantation productivity. Assessment and yield prediction in plantation. Nutrient and irrigation management in plantation, INM, mulching, weed management - Mechanization of plantation operation - Protection and after care of plantation - Pruning and thinning of plantation for quality wood production - Rotation in plantation - Failure of plantations. Management of coppice stand. Industrial Plantation – Importance - Demand and supply scenario in India - Wood based industries - NTFP Plantations - Choice of species and plantation technology - Silvicultural packages for Eucalyptus, Casuarina,

Acacias, Silver Oak, Ailanthus, Bamboo, *Melia dubia*, Gmelina, Teak, Sandal and Red sanders. Post-harvest silvicultural techniques. Tools and Implements used in logging operation. Reduced impact logging (RIL), Concept - scope and objectives – impediments to adoption - difference between reduced impact logging and conventional logging. Economics of commercial plantation.

Practical

Plantation planning - Preparation of plantation calendar- Arrangement and preparation of improved planting stock - Planting geometry and calculation of planting stock - Site preparation and planting - Studies on wood-based industries - Plantation geometry - Canopy architecture and management, root pruning and root management, stem management and inter-callery augmentation. Plantation techniques for difficult sites - saline, alkaline soils, rocky area and waterlogged areas and other inhospitable sites. Modern plantation techniques for Eucalyptus, Casuarina, Teak, Acacias and Bamboo plantations - Production technology for energy plantations and NTFP Plantations - Economics of commercial plantation.

Suggested Readings

1. Dwivedi, A.P.1992. Principles and Practices of Indian Silviculture, Surya Publications.420p.
2. Julius, E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
3. Khanna, L.S. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
4. Lamprecht. 1986. Silviculture in the Tropics. Verlag Paul Parey, Hamburg und Berlin.

Forest Growth Modelling 2 (1+1)

Objective

To impart knowledge on forest growth model for predicting the future of the forest by incorporating the silvicultural treatments

Theory

Model development and validation - Important uses - Indices of competition - Two-sided competition (Distance-independent vs. Distance-dependent) - One-sided competition (Distance-independent vs. Distance-dependent) – Limitations - Low predictive power (Distance-independent vs. distance-dependent) - Influence of sampling design. Whole-stand models - Yield tables and equations - Compatible growth and yield equations - Systems of equations - State-space models - Transition matrix models. Size-class models - Stand table projection - Matrix models – Diameter (Class models and Cohort models) - Single-tree distance-dependent models - Tree-list distance-independent models. Stand-level mortality – Individual tree-level mortality - Mechanistic models of mortality -Development and application of mortality equations. Genetic improvements (Stand-level and Tree-level) - Early stand treatments (Stand-level and Tree -level) –Thinning (Stand-level and Tree-level) – Fertilization (Stand-level and Tree-level)- Combined thinning and fertilization (Stand-level and Tree-level) – Harvesting (Stand-level and Tree-level).Types of hybrid models - Statistical growth equations with physiologically derived covariate -Statistical growth equations with physiologically derived external modifier - Allometric models -Comparison to statistical models.

Practical

Collection of biometric data for growth model preparation – Sampling design analysis. Whole-stand models - Yield tables and equations. Mortality model and mechanism of model. Modelling silvicultural treatments are Genetic improvements - Early stand treatments –Thinning – Fertilization - Combined thinning and fertilization – Harvesting models. Benefits and uses of working out the growth models.

Marketing and Certification of Wood Products 2 (1+1)

Objective

To impart knowledge on marketing of the wood products and certification of the forest plantations and wood

Theory

Market, definition, types of markets for timber produce, Economic features of specialized markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in timber, composite wood, pulp wood, match wood. Demand forecasts. Price determination in timber produce. Domestic and International demand and trade in timber products. Market integration and market inefficiencies in timber and measures to check inefficiencies. Role of cooperative societies and NGO's in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. WTO - background, structure, functions and decision-making process. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO). Forest Certification- Definition of forest certification- Origin of certification- process and methods – Advantages and Disadvantages. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Organizations involved in certification. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Program for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Case studies in forest certification.

Practical

Questionnaire preparation for primary data collection; Visit to various wood based (Timber, composite wood, pulp wood, match wood) and non-wood-based industries to study its role in marketing; identification of marketing channel and estimation of price spread for major timber and non-timber forest products; Estimation of marketing efficiency; Analysis of price and quantity data of timber a produce for examining trend, seasonal, cyclical and secular variations. Valuation of timber (Existence value, use and option values, intrinsic value etc).

Suggested Readings

1. Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
2. Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
3. Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.
4. Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.
5. Muraleedharan, P. K., Subramanian, K. K., and Pillai, P. P. 1998. Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p.
6. Tewari, D. N. 1995. Marketing and trade of forest produce; International Book Distributors (Book Sellers and Publishers), Dehradun, India. 140p

Restoration of Degraded Lands 3 (2+1)

Objective

To impart practical understanding about rejuvenation of forest with tree vegetation and to develop skills on tacking different problem soils with suitable vegetation

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/ wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation / reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas- explanation, impact on pant growth and Biodrainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programs on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development program

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (Eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation program.

Suggested Readings

1. Hegde NG 1987. Handbook of Wasteland Development. BAIF, Pune 102p.

2. ICAR 1977. Desertification and its Control. ICAR, New Delhi 358p. National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix.
3. Imeson A 2012. Desertification, Land Degradation and Sustainability, John Wiley and Sons.
4. Kumar Anil and Pandey R N 1989.Wastelands Management in India. Ashish Publishing House, New Delhi.
5. Luna R K 1989 Plantation Forestry in India, International book distributors, Dehra Dun. Forestry; Ministry of Agriculture and Irrigation, Govt. of India, New Delhi 457p.

Dendro- biomass and Energy Plantation 3 (2+1)

Objective

To develop skill and expertise among the students regarding the Forest Energy Resources

Theory

Forests and Dendro-energy – Definition and Scope Role of Forests – Forest Energy Potential – Status of Forest Biomass – Applications of forest biomass energy resources – Advantages and Disadvantages of Forest Biomass energy resources. Introduction – Biomass Production – Photosynthetic and energy production– Biomass Composition – (Cellulose, Hemicellulose, Lignin, Starch, Proteins, Mineral Elements, Other components (Organic and inorganic) – Biomass Energy Content – Properties of Forest Biomass – Physical – Thermodynamic and other properties. Energy Trees – Short rotation species – Eucalyptus, Casuarina, Subabul, Prosopis and Bamboos – Medium rotation species – All Acacias – Long rotation species – Energy characteristics of the species – Tree borne oilseeds as a source of biofuel – Dendro energy production technology – Site selection – Choice of species – Plantation establishment– Maintenance of plantation– Protection – Harvesting of biomass – Harvesting Methods – Plantation residues – Types – Utilization and value addition through briquetting –– Yield potential of different dendro energy species. Dendro energy models – Farm Forestry – Agroforestry – Captive Plantations – High Density Short Rotation Model (HDSR) – High Density Energy Plantation (HDEP) – Clonal Plantations – Monoclonal and Polyclonal Model – Sporadic model – Linear model – Paired row model– Establishment and management – Economics – Handling of Biomass – Drying biomass material –Drying techniques – Biomass storage and Transportation – Sustainable Production of woody biomass for energy generation. Introduction– Species selection – Energy species amenable for farm forestry – Types of farm forestry models. CDM approach– CDM benefits through Energy Plantations – Carbon sequestration potential of energy trees. Contract energy farming – Scope and methods – Dendro biomass power plants in India – Scope and potential.

Practical

Study on natural and artificial methods for tree biomass production. Identifying suitable tree species (Short rotation, medium rotation and long rotation species) for energy generation. Estimation of calorific value for Short rotation, medium rotation and long rotation species. Study on energy characteristics of the species. Dendro energy production technology – Site selection – Plantation establishment – Plantation management – Harvesting operation. Biomass estimation in trees by using both destructive and non-destructive methods. Plantation residues for dendro-energy production. Dendro energy models. High Density Short Rotation Model (HDSR) and High Density Energy Plantation (HDEP).

Suggested Readings

1. Divya, M.P., K.T. Parthiban, K. Vanangamudi, K. Srinivasan and M. Govinda Rao. 2008. A text Book on Social Forestry and Agroforestry. Sathish Serial Publishing House, Delhi. ISBN: 81-89304-48-8. P.315.
2. Luna, R.K. 1989. Plantation Forestry in India. International Book Distributors. Pp. 320 – 338.
3. Khanna, L.S. 1999. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi. ISBN: 81-58-933-01-4. P.473.
4. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajedran P. and Durairasu, P. Industrial Agroforestry Perspectives and Prospectives. Scientific Publishers. Jodhpur. P. 396
5. Parthiban, K.T., Subbulakshmi, V., Umesh Kanna, S., Sekar, I., Rajendran, P., Durairasu, P. and Suresh, G. 2013. Dendro Power Generation - Principles and Applications. FCRI, Publications. P.275.
6. Parthiban, K.T, Paramathma, M. and Neelakantan, K.S. 2006, Clonal forestry, FC&RI publication (ISBN no.81-902081-2-8). P. 209.

Plantation and Climate Change Mitigation 2 (2+0)

Objective

To understand the scenario of climate change and international treaties on climate change, adaptive silviculture for climate change mitigation, silviculture for conservation of ecosystems

Theory

Global climate change - factors involved greenhouse gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change. Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP, LULUCF, REDD++ and CDM. National action plan for climate change - Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plan on Climate Change. Silviculture and sustainability- criteria and indicators for sustainable plantation forestry in India. CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change. Analog forestry for site productivity and carbon value. Disturbance- natural and anthropogenic, short- and long- term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans. Invasive – major invasive species in forests – area affected and methodology for mapping. Eradication methods- management. Restoration of invasive affected areas – types - methods approaches, strategies and opportunities. Silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting. Silviculture Climate resilience - definition - resilient forestry - concept - practices and models - resilient forestry practices for different land use systems - Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Silviculture of old growth stands and sacred grooves- their ecological significance and biodiversity values. Silviculture activities for conserving forest resources. Expanding forest and tree cover area - TOF sector in India. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests.

Suggested Readings

1. Adam Markham (Editor). 2010. Potential Impacts of Climate Change on Tropical Forest Ecosystems. Amazon publishers.
2. Anderson, P, and Palik, B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
3. Bravo, F., LeMay, V., Jandl R. and Gadow, von K. (Eds). 2008. Managing Forest Ecosystems: The Challenge of Climate Change. Springer publication. Pp 324
4. Claussen, Eileen, Cochran, Vicki, Davis, Arroyo and Debra, P. and Pew. 2001. Climate Change: Science, Strategies, and Solutions. Brill Academic Pub. Pp 393
5. Streck, Charlotte, O'Sullivan, Robert, Richard Tarasofsky, G. and Janson-Smith, Toby. 2011. Climate Change and Forests: Emerging Policy and Market Opportunities. Brookings Institution Press

Plant Biochemistry 2 (1+1)

Objective

To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid-base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver-Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO2 fixation, regulation of photosynthesis. Metabolism of carbohydrates -glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of

oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0-7167-8724-5.
2. Buchanan, Bob B. Gruissem, Wilhelm and L. Jones, Russell. Biochemistry and Molecular Biology of Plants.
3. Jeremy M., Berg, Lubert Stryer, Tymoczko, John and Gregory Gatto. Biochemistry.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer, David T. An Introduction to Practical Biochemistry.
6. Rao, Beedu Sashidhar, Deshpande, Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam, S and Manickam, A. 2009. Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B., Krishnaveni, S. and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet, Donald and Voet, Judith. Biochemistry.
10. Wilson, K. and Walker, J.M. 2000. Principles and techniques of Practical Biochemistry

Research Methodology 2 (1+1)

Objective

To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey-based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

Statistical Packages for Data Analysis **1 (0+1)**

Objective

To learn the art of data collection, processing, analysis and interpretation will be developed to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G. (1994). Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

B) `Multi-functional agroforestry

1. Agroforestry system (2+1)
2. Interactions in Agroforestry Systems (1+1)
3. Agroforestry and Climate Change Mitigation (2+0)
4. Industrial agroforestry (2+1)
5. Ecotourism 2+1)
6. Dendro-biomass and energy plantation (2+1)
7. Introduction to Agronomy and Crop Production Technology (2+1)
8. Plant Biochemistry (1+1)
9. Research Methodology (1+1)
10. Statistical Packages for Data Analysis (0+1)
11. Agroforestry business incubation (1+1)
12. Internship with agroforestry-based institutions/industries (0+2)

Agroforestry Systems 3 (2+1)

Objectives

1. To impart knowledge on suitable agroforestry practices for different land uses
2. To study their role in ecosystem services
3. To teach recent trends in agroforestry research and development

Theory

Agroforestry - objectives, importance, potential and limitations for implementation. Agroforestry systems - simultaneous and sequential agroforestry systems, Basis for classification of agroforestry systems and principles - Structural, functional, ecological and socio-economic basis of classification - Indigenous vs exotic tree species in agroforestry, intraspecific variations- Tree crown architecture and tree root architecture – silvicultural options to minimize negative interactions- Ideotype concept for selection of multipurpose trees and nitrogen fixing trees. Land use – Land capability classification- Survey and analysis of land use system Description of agroforestry systems viz. agri-silviculture, silvipasture, agro-silvipasture, horti-silvipasture -Description of other systems – silvi-mediculture, silvi-pisciculture, silvi-apiculture, urban agroforestry systems and aqua forestry- Wind break and shelter belt agroforestry systems – Agroforestry practices for wetlands – Agroforestry practices for garden land - Agroforestry practices for semi-arid and arid lands – Agroforestry practices for coastal and hilly areas - Bio saline agroforestry. Ecosystem services – Provisional services – food, fuel, fodder, fibre, timber and non-timber resources, Regulating services - Agroforestry for soil enrichment-biodiversity conservation - improved air and water quality - Cultural services – Religious, aesthetic, recreation - Supporting services – education, soil and environmental conservation, carbon sequestration, climate change mitigation. Nutrient cycling and nutrient pumping in agroforestry systems -Soil productivity and management in agroforestry - Plant management in Agroforestry – manipulation of trees, population densities and mixture of trees and herbaceous crops – ecosystem structure and function- interactions relevant to agroforestry. Formulation of Agroforestry projects - preparation of bankable projects, economic analysis of various agroforestry systems - Budget and other constraints - Financial and socio-economic analysis of agroforestry projects - Role of time in decision making- social and private discount rate - Role of risk and uncertainty in decision making- Participatory Rural Appraisal (PRA) -Rapid Rural Appraisal (RRA) tools for Agroforestry problem diagnosis.

Practical

Studies on global agroforestry systems - Designing agroforestry practices for wet lands - garden lands - dry lands -coastal and hilly areas - multitier systems - light intensity and shade effect under agroforestry systems-quantifying tree-crop interaction by LER method allelopathic studies- case studies on role of agroforestry in carbon sequestration, biodiversity conservation and air and water quality-Agroforestry D &D exercise - Preparation of bankable projects - financial and economic appraisal - Profitability analysis of various agroforestry systems.

Suggested Readings

1. Divya, M.P., Parthiban, K.T., Srinivasan, K., Vanangamudi, K. and M. Govinda Rao. 2008. A Textbook on Social Forestry and Agroforestry. Satish Publishers, Delhi, 315p.

2. Janaki, R. R., Alavalapati and Mercer, D. Evan (Eds). 2005.Valuing Agroforestry Systems, Methods and Applications. Advances in Agroforestry, Vol. 2, Kluwer Academic Publishers.314p.

3. Jose, S. 2009. Agroforestry for Ecosystem Services and Environmental Benefits. Springer Science, The Netherlands. 266p.

4. Nair, P.K.R.1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, 499.

5. Kumar, B.M and Nair, P.K.R. 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry, Vol-8, Springer Science, The Netherlands p307.

6. Ong, C. K. and Huxley, P.K. 1996. Tree Crop Interactions -A Physiological Approach. ICRAF.

7. Parthiban, K.T. Ramah, K., Sivakumar, K and Rao G.R. 2019. Multifunctional Agroforestry Volume – I &II. Jaya Publishing House, New Delhi.

8. Parthiban, K. T. and Keerthika, A. 2021. A Text book of Agroforestry – Principles, Practices and Applications, Agrobios, Jodhpur.

9. Puri, Sunil and Panwar, Pankaj. 2007. Agroforestry systems and practices. New India Publishing Agency, New Delhi, 641p.

10. Raj, Antony Joesph and Lal, S. B. 2014. Agroforestry- Theory and Practices, Scientific Publishers (India), New Delhi.

Interactions in Agroforestry Systems 2 (1+1)

Objective

To make students understand the concepts of tree- crop interactions, their quantification and techniques to neutralize the negative interactions

Theory

Agroforestry –general principles of plant productivity – photosynthesis – respiration – plant productivity – manipulation of photosynthesis in Agroforestry – multipurpose tree species - fodder trees – fuel wood trees – fruit trees – industrial wood species – other woody perennials – herbaceous species. Tree-crop interface – factors influencing tree – crop interaction- types of tree –crop interactions based on effect, association and output, position – positive interactions – competition, complementarity in resource sharing – above ground and below ground interaction. Negative interaction – competition, allelopathy – characteristics of tree species and crops – Allelochemicals - source of allelochemicals - process and leaching of allelochemicals - Tree management – manipulation of densities and arrangement of trees – Tree crown and root manipulation - Animal-tree-crop interaction. Method for quantifying interactions, principles of resource capture and utilization of light and water, nutrition and space. Tree-soil-crop interactions- nitrogen fixing trees interactions in agroforestry systems – Use of radioisotopes in tree-crop interaction studies - Root distribution of trees and crops. Management options to neutralize negative interactions – tree husbandry practices for alleviating competition – thinning, pruning, pollarding, lopping, hedging etc. – management of light interception.

Practical

Different methods for quantifying interactions- Studies on allelopathy - Laboratory bioassay with tree /crop parts and rhizosphere soil - different plant mixtures and estimating tree-soil-crop interactions - Working out indices for evaluating agroforestry systems - Measurement and interpretation of light interception in agroforestry system - Interpretation of yield responses to shelter, soil water and drainage measurement - transpiration measurement, quantifying root distribution.

Suggested Readings

1. Avery, M.A. Cannel, M.G.R. and Ong, C.K. 2005. Biophysical Research for Asian Agroforestry. Oxford and IBH Publishing Co. Pvt. Ltd
2. Dagar, J.C. and Tewari, J.C. 2016. Agroforestry Research Developments.
3. Parthiban, K.T. and Keerthika, A. 2021. A Text book of Agroforestry – Principles, Practices and Applications, Agrobios, Jodhpur.
4. Raj, Antony Joesph and Lal, S.B. 2014. Agroforestry- Theory and Practices, Scientific Publishers (India), New Delhi.

Agroforestry and Climate Change Mitigation 2 (2+0)

Objective

To develop understanding of students about ecosystem services, environmental benefits and quantification of ecosystem services along with their valuation.

Theory

Global CO_2 emission and patterns of climate variability - Multifunctionality of Agroforestry - Major ecosystem services, environmental benefits and international conventions, charters on climate change (UNFCCC, UNCCD, Agroforestry and Kyoto protocol – genesis, goals, signatories and latest developments - climate change negotiations (CoP), Reduced Emissions from Deforestation and Degradation (REDD) and biodiversity conservation (CBD) – an overview. Agroforestry for carbon conservation, sequestration, substitution – role and potential of various agroforestry systems - Estimates of carbon sequestration potential – measurement – Aspects and criticisms, Factors affecting above and belowground carbon sequestration potential. Agroforestry for soil enrichment – mechanisms – litter and fine root dynamics, rhizo-deposition and other rhizosphere effects, symbiotic and free-living N_2 fixation, mycorrhizal associations - Soil and water conservation benefits through agroforestry. Agroforestry for biodiversity conservation - Synergy with climate change mitigation - Landscape connectivity for wildlife, supporting the pollinators of plant species - Agroforestry for improved air and water quality - Non-point source pollution in Indian agro-ecosystems - Riparian buffers for alleviating agricultural non-point source pollution – Pollution reduction measures in forestry. Private profitability vs. social profitability - exclusion or inclusion of social benefits and costs and non-market values, or externalities - Theory of externalities, effect of environmental costs and benefits on the profitability of agroforestry practices - Valuing environmental services - Profitability of timber, pulp wood, ply wood and match wood-based agroforestry systems - Costs and benefits in agroforestry- valuation of inputs and outputs- environmental outputs.

Suggested Readings

1. Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. Agroforestry development: Anenvironmental Economic Perspective. Agroforestry Systems. 61: 299– 310.
2. Huxley P. 1999. Tropical Agroforestry. Blackwell.
3. IPCC. 2007. Climate Change 2007. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
4. Jain SK and Singh P. 2000. Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) In Uttar Pradesh (India). Agroforestry Systems. 49: 255–273.
5. Jeffers JNR. 1978. An Introduction to System Analysis with Ecological Application. Edward Arnold.
6. Jose S. 2009. Agroforestry for Ecosystem Services and Environmental Benefits: An Overview. Agroforestry Systems. 76: 1-10.
7. Lyngbaek AE, Muschler RG and Sinclair FL. 2001. Productivity and Profitability for Multistrata.
8. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer, Netherlands.
9. Organic Versus Conventional Coffee Farms in Costa Rica. Agroforest. Syst. 53: 205–213.
10. Schroth G and Sinclair F. 2003. Tree Crops and Soil Fertility: Concepts and Research Methods, CABI, Wallingford, UK.
11. Young A. 1997. Agroforestry for Soil Management. 2nd edn. CABI, Wallingofrd, UK.

Industrial Agroforestry 3 (2+1)

Objective

To develop skill and expertise on Industrial Agroforestry and associated supply and value chain management

Theory

Forests and Agroforestry – Extent of Area - Current status – National and International scenario – Role of Forests in Industrial sector – Industrial raw material – Demand and supply – Indigenous and exotic industrial resources – Policy and legal issues in industrial wood plantations and agroforestry - Major wood-based industries in India – Timber, pulpwood, plywood, panel. match splints, sports and goods, agricultural implements, construction, body building, ship industry, etc. - raw material requirements and procurements – Industrial important NTFPs – Scope and importance - Promotion of industry-based farm and agroforestry – Strategies for promotional activities. Industrial Agroforestry plantations – Status in India – Preferred species – Plantation management and establishment – Precision silvicultural techniques for Timber, pulp and paper, Match, plywood, dendro power– Propagation and plantation techniques – Pest and disease management for major industrial agroforestry tree species. Harvest operation – Mechanization – Yield potential. Value addition – Utilization of plantation and industrial residues – Briquettes and pellets. Supply Chain - Definition – Concept – Supply chain network – Logistic activities – Marketing system – Marketing type and channel – Price patterns of various agroforestry industrial wood products – Contract farming - Definition – Concept and methods of contract farming – Contract tree farming systems in India – Experiences of wood based industries in contract farming – buy back– Corporates in Industrial Agroforestry – International corporate involved in Industrial Agroforestry –Success stories

- Corporate social responsibilities – Tree Insurance Scheme (TIS) – Felling regulatory mechanism. Consortium of Industrial Agroforestry – TNAU Model for sustaining industrial agroforestry - Agroforestry business innovations and entrepreneurship development - Agroforestry based business incubation opportunities. Impact of Industrial Agroforestry – Economic and Ecological impacts: Climatic, edaphic and biotic– Carbon sequestration – Carbon storage potential of Industrial Agroforestry and carbon trading mechanism of Industrial Agroforestry – Socio-economic impacts – Rural livelihood improvement and economic return – Environmental impact.

Practical

Study of various wood based industries – Preferred species (State specific) – Timber agroforestry -Pulp and paper based agroforestry– Plywood based agroforestry – Matchwood based agroforestry – Dendro energy agroforestry – NTFPs agroforestry - Plantation management – Harvest and mechanization – Value addition Technology – Contract tree farming – Economics – Bankable project preparation - Visit to wood and non-wood based industries – Exposure to Business opportunities –DPR preparation for industrial agroforestry based business model.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336
2. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajendran, P. and Durairasu, P. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
3. Parthiban, K.T. and Seenivasan, R. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publishers. Jodhpur. p 629.
4. Parthiban, K.T. and Keerthika, A. 2020. Textbook on Agroforestry – Principles, practices and Applications. Agrobios, Jodhpur, p256

Ecotourism 3(2+1)

Objective

To develop knowledge, understanding, and appreciation of environmentally responsible travel to relatively undisturbed natural areas that promote biodiversity conservation, has low negative visitor impact, and provide socio-economic benefits to the local stakeholder communities

Theory

Ecotourism – Definition - History of tourism and evolution of ecotourism. Various forms of tourism - Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism. Organised tours and Free Independent Traveller – World Tourism Organization. Concept of ecotourism and flaws in real world. Problems with definition of ecotourism and criticisms. Dimensions of ecotourism and the criteria to qualify for ecotourism. Declaration – Different forms of ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Ecotourism-its potential in developing countries- Poverty and biodiversity, Ecotourism as a rural development strategy in tropical countries Ecotourism as a land

use- possibilities of integration – Ecotourism policies at national and local level. Environmental Impacts of ecotourism and its mitigation - Case studies from different parts of the world- Concept of "scale". The checks and controls and institutional mechanisms for controlling the environmental impacts, Mitigation of pollution. Social Impacts of ecotourism and precautionary principles to avoid ill effects Stories from different parts of the world narrating ecotourism development and its influence on society and their culture – The societal advantages and the negative impacts of ecotourism development – Ways forward to address the negative social impacts Indigenous people and ecotourism. Ecotourism economics and business – Investment of international agencies like World Bank in ecotourism projects Ecotourism economics at macro and micro economic level in developing countries Ecotourism as a green business and role of green consumerism – Business plans- unique selling points for marketing – Potential of internet in marketing ecotourism – Payments for Environmental services and role of ecotourism Multiplier effects, opportunity costs and leakage in ecotourism industry Sharing ecotourism revenues among stakeholders – Training in ecotourism to deliver quality service. Ecotourism as a vehicle for the conservation of common property resources – potentials and pitfalls, Dangers involved in management of common property resources Relations between the government and the private sector. Ecotourism and Protected Areas Changing paradigms in the Protected Area Management Support at international level for ecotourism Integrated Conservation Development Projects (ICDPS) and role of ecotourism Community based ecotourism programs. Planning and management of ecotourism – Ecotourism plans and management of visitors and other resources including human and natural resources – Quality control, codes of conduct etc. Use of GIS and ICT for effectively managing and planning ecotourism – Criteria and indicators for sustainable management and monitoring – Charter for Sustainable Tourism – Sustainability issues in ecotourism management and ecotourism certification. Ecotourism design – Role of socio-economic factors in decision making – Designing ecotourism products using local technologies – Carrying capacity considerations. – Use of GIS in ecotourism. Ecotourism markets and influences of climate change Existing ecotourism markets and ecotourism market segmentation – Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets.

Practical

Preparation of a thematic compendium after extensive and original independent investigation about the chosen Protected Area. Be familiar with Government policy and legislation, the current policies regarding the component land uses of the study site. Stakeholder analysis and social Impacts Assessment. Identify different stakeholders at different levels. Based on this perform a stakeholder analysis and then conduct social surveys to gather the information required for assessing the impacts of current management and to explore the intervention needed in the chosen protected area. Ecological surveys including Environmental Impact Assessment. Assess the ecological impacts of current human use using standard techniques in order to identify the intervention needed in the chosen protected area.

Suggested Readings

1. Bhatt, S. and Liyakhat, S. 2014. Ecotourism Development in India: Communities, Capital and Conservation
2. Lindberg, K., Wood, M. E. and Engeldrum, D. 1998. Ecotourism- A guide for planners and managers (Environment and Development). Foundation Books

3. Page, S. J. and Dowling, R. K. 2002. Ecotourism. Pearson Education Limited, Essex. The Ecotourism Society, Vermont.
4. Weaver, D. 2002. Ecotourism. Milton, Queensland, Australia: John Wiley and Sons Australia.

Dendro- biomass and Energy Plantation 3 (2+1)

Objective

To develop skill and expertise among the students regarding the Forest Energy Resources

Theory

Forests and Dendro-energy – Definition and Scope Role of Forests – Forest Energy Potential – Status of Forest Biomass – Applications of forest biomass energy resources – Advantages and Disadvantages of Forest Biomass energy resources. Introduction – Biomass Production – Photosynthetic and energy production– Biomass Composition – (Cellulose, Hemicellulose, Lignin, Starch, Proteins, Mineral Elements, Other components (Organic and inorganic) – Biomass Energy Content – Properties of Forest Biomass – Physical – Thermodynamic and other properties. Energy Trees – Short rotation species – Eucalyptus, Casuarina, Subabul, Prosopis and Bamboos – Medium rotation species – All Acacias – Long rotation species – Energy characteristics of the species – Tree borne oilseeds as a source of biofuel – Dendro energy production technology – Site selection – Choice of species – Plantation establishment– Maintenance of plantation– Protection – Harvesting of biomass – Harvesting Methods – Plantation residues – Types – Utilization and value addition through briquetting –– Yield potential of different dendro energy species. Dendro energy models – Farm Forestry – Agroforestry – Captive Plantations – High Density Short Rotation Model (HDSR) – High Density Energy Plantation (HDEP) – Clonal Plantations – Monoclonal and Polyclonal Model – Sporadic model – Linear model – Paired row model– Establishment and management – Economics – Handling of Biomass – Drying biomass material –Drying techniques – Biomass storage and Transportation – Sustainable Production of woody biomass for energy generation. Introduction– Species selection – Energy species amenable for agroforestry – Types of agroforestry models– Silvi agriculture – Silvi pastoral based energy farming– Alley cropping– CDM approach– CDM benefits through Energy Plantations – Carbon sequestration potential of energy trees. – Contract energy farming – Scope and methods – Dendro biomass power plants in India – Scope and potential.

Practical

Study on natural and artificial methods for tree biomass production. Identifying suitable tree species (Short rotation, medium rotation and long rotation species) for energy generation. Estimation of calorific value for Short rotation, medium rotation and long rotation species. Study on energy characteristics of the species. Dendro energy production technology – Site selection – Plantation establishment – Plantation management – Harvesting operation. Biomass estimation in trees by using both destructive and non-destructive methods. Plantation residues for dendro-energy production. Dendro energy models. High Density Short Rotation Model (HDSR) and High-Density Energy Plantation (HDEP).

Suggested Readings

1. Luna, R.K. 1989. Plantation Forestry in India. International Book Distributors. Pp. 320 – 338.

2. Divya M.P., Parthiban, K.T., Vanangamudi, K., Srinivasan, K. and Rao, M. Govinda. 2008. A text Book on Social Forestry and Agroforestry. Sathish Serial Publishing House, Delhi. ISBN: 81-89304-48-8. P.315.
3. Khanna, L.S. 1999. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi. ISBN: 81-58-933-01-4. P.473.
4. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajendran, P. and Durairasu, P. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
5. Parthiban, K.T, Subbulakshmi, V., Umesh Kanna, S., Sekar, I., Rajendran, P., Durairasu, P. and Suresh, G. 2013. Dendro Power Generation - Principles and Applications. FCRI, Publications. P.275.
6. Parthiban, K.T., Paramathma, M. and Neelakantan, K.S. 2006, Clonal forestry, FC&RI publication (ISBN no.81-902081-2-8). P. 209.

Introduction to Agronomy and Crop Production Technology (2+1)

Objective

To impart the basic and fundamental knowledge of Agronomy

Theory: Agronomy and its scope: Definition, Meaning and scope of Agronomy; Art, science and business of crop production, relation of Agronomy with other disciplines of Agricultural Science, Fields crops and classification, importance, ecology and ecosystem, Seeds and sowing: Definitions of crops, variety and seed. Factors affecting crop stands establishment: good quality seed, proper tillage, time of sowing seed rate, depth and method of sowing: broadcasting, drilling, dibbling, transplanting etc. Tillage and tilth: Definition, objectives, types, advantages and disadvantages of tillage including conservation tillage. Crop density and geometry: plant geometry and planting geometry, its effect on growth, yield Crop nutrition: Definition of essential nutrients, criteria of essentiality, functional elements, classification of essential nutrients, role of macro and micro nutrients. Nutrient absorption, active and passive absorption of nutrients, forms of plant nutrients absorbed by plants, Combined / un-combined forms Manures and fertilizers, nutrient use efficiency: Sources of nutrients: Inorganic (fertilizers), organic (manures) and bio-fertilizers; their classification and characteristics, method of preparation and role of organic manures in crop production Integrated Nutrient Management: Meaning, different approaches and advantages of INM Green manure- role in crop production: Definition, objectives types of green manuring, desirable characteristics, advantages and limitations of green manuring , Water management: Water resources of the world, India and the state; Soil Moisture Constants –gravitational water, capillary water, hygroscopic water, Soil moisture constants, Concept of water availability to plants, soilplant-water relationship, crop water requirement, water use efficiency, Methods of irrigation : Scheduling of irrigation, different approaches of scheduling irrigation Weeds: Definition, Importance and basics of classification of weeds and their control Cropping systems: Factors affecting cropping systems, major cropping patterns and systems in the country. Sustainable crop production: Definition, importance and practices, natural resources and conservation pollution and pollutants, Allelopathy: Meaning and importance in crop production, Growth and development of crops: Definition, Meaning and factors affecting growth and development.

Practical: A visit to Instructional Crop farm and study on field crops, Identification of crops, seeds, fertilizers, pesticides, Crops and cropping systems in different Agro-climatic zones of the state, Study of some preparatory tillage implements, Study of inter tillage implements, Practice of ploughing / puddling, Study and practice of inter cultivation in field crops, Numerical exercises on calculation of seed, plant population and fertilizer requirement, Study of yield contributing characters and yield estimation of crops, Identification of weeds in different crops, Seed germination and viability test of seed, Practice on time and method of application of manures and fertilizers, Measurement of soil moisture by gravimetric and volumetric method and bulk density,

Suggested readings

1. Donn, William L. 1965. Meteorology. McGraw-Hill Book Co. New York.
2. Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
3. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers 6. Ludhiana.
4. Reddy S R. 2008. Principle of Crop Production. Kalyani Publisher, Ludhiana.
5. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, 3. Nagpur. 90.

Plant Biochemistry 2 (1+1)

Objective

To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid-base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver-Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO_2 fixation, regulation of photosynthesis. Metabolism of carbohydrates -glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L (2007) Biochemistry. 7th edn. Wiley Eastern Ltd. ISBN:0-7167-8724-5.
2. Berg Jeremy M., Stryer Lubert, Tymoczko John and Gatto Gregory. Biochemistry.
3. Buchanan Bob B, Gruissem Wilhelm and Jones, Russell L.. Biochemistry and Molecular Biology of Plants.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer David T. An Introduction to Practical Biochemistry.
6. Rao Beedu Sashidhar and Deshpande Vijay Experimental Biochemistry: A student companion.
7. Sadasivam S and Manickam A (2009), Biochemical Methods, 3rd edn, New Age International.
8. Thayumanavan B, Krishnaveni S and Parvathi K (2004), Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet Donald and Voet Judith. Biochemistry.
10. Wilson K and Walker J M (2000), Principles and techniques of Practical Biochemistry

Research Methodology 2 (1+1)

Objective

To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey-based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis

Statistical Packages for Data Analysis 1 (0+1)

Objective

The art of data collection, processing, analysis and interpretation will be developed to the translate simple data in to scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Jayaraman, K. and Rugmini, P. 1990. Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.
2. Nigam, A.K. and Gupta, V.K.1979. Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
3. Panse, V. G. and Sukhatme, P.V. 1967. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
4. Petersen Roger G. 1994. Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

C) High Yielding Short Rotation (HYSR) Forestry

1. Applied Tree Improvement (2+1)
2. Reproduction Biology of Tree Crops (2+1)
3. Biometrical Genetics in Tree Breeding (1+1)

4. Marker Assisted Breeding in Forestry (2+1)
5. Tissue Culture Application in Forestry (1+2)
6. Controlled Breeding in Tree Crops (0+2)
7. Tree Seed Orchards (2+1)
8. Forest Genetic Resources (2+0)
9. Clonal Forestry (1+1)
10. Plant Biochemistry (1+1)
11. Research Methodology (1+1)
12. Statistical Packages for Data Analysis (0+1)
13. Internship with Tree Breeding and Biotechnology-Based Institutions/Industries (0+2)

Applied Tree Improvement **3 (2+1)**

Objectives

1. To impart applications of principles of tree breeding and improvement to the students
2. To breed new varieties with increased productivity to cater needs of user agencies

Theory

General concept of tree breeding, tree improvement and forest genetics – History of tree improvement – Reproduction in forest trees - Mode of Reproduction – Significance – Pollination – Types of pollination – Pollination mechanism - Pollination in cross pollinated and self-pollinated tree species. Pollen dispersion distances, pollinators and their energetics. Pollen handling - Forced flowering for seed orchard manipulation. Variation in trees, importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races – Selective breeding methods. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding for forest trees. Indirect selection for biotic and abiotic stresses. Wood and tree improvement – wood properties and their genetic relationships. Progeny selection and clonal selection – Concepts – scope – limitations. Progeny and clonal testing. Estimating genetic parameters and genetic gain breeding values. Average performance of half sibs and full-sibs. GxE interaction in trees. Seed orchards – type, functions and importance. Exotic forestry and tree breeding - gains and risks - donor and receptor countries - genetic improvement of exotics. Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Natural and artificial hybrids - Indian examples – Teak, sal, shisham, eucalypts, acacias, pines and poplars. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Mutation Breeding and its application in tree improvement. Biotechnology in tree improvement. Genetically Modified tree species – Varietal registration- procedures-conducting DUS test. Tree DUS testing- development of descriptors for trees. Economics of tree improvement.

Practical

Identification of ecotypes, races, and land-races in natural forest. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Progeny and clone testing. Mating and field designs. Estimating genetic parameters and genetic gain - Visit to species, provenance and

progeny trials. Visit to seed orchards. Comparison of parents and their putative hybrids. Macro and micro propagation. Tree Improvement Programs in Timber species and non-Timber species.

Suggested Readings

- FAO. 1985. Forest Tree Improvement, FAO. Publication
- Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No. 34
- Khosla PK. 1981. Advances in Forest Genetics. Ambika Publ., New Delhi
- Mandal AK and Gibson GL. (Eds). 1997. Forest Genetics and Tree Breeding. CBS
- Parthiban, K.T, Krishnakumar, N. and Devanand, P.S. 2020. Tree Breeding and Improvement – Theories and Techniques. Scientific Publishers. Jodhpur
- Sandeep Kumar and Matthias Fladung. 2005. Molecular genetics and breeding of forest trees, International book distribution Co. India 436 pages
- Surendran C, Sehgal RN and Paramathma M. 2003. Text Book of Forest Tree Breeding. ICAR Publ.
- White JW. 1976. Introduction to Forest Genetics. Academic Press
- Zobel BJ and Talber J. 1984. Applied Forest Tree Improvement. John Wiley and Sons.

Biometrical Genetics in Tree Breeding 2 (1+1)

Objective

To impart knowledge in the field of biometry as applied to breeding population, provinces and making experiment in forest genetics and tree breeding

Theory

History and principles of quantitative genetics in forest trees and importance of qualitative and quantitative traits in tree breeding; Basic statistical Tools-Mean, mean, mode, standard deviation; Experimental design, principles and components of experimental design; Phenotypic variance, genotypic variance and its partitioning, models of gene action. Nature of Gene Action - Dominance and Epistatic-Qualitative and quantitative traits in tree breeding; Biometrical Techniques used for assessing the variability in germplasm collection various types of variability – Significance; Heterosis, types of heterosis, Factors affecting heterosis, Genetic basis of heterosis; Heritability, Types of heritability – methods of estimation of heritability, genetic gain and genetic advance. Association analysis - Correlation coefficient analysis – Types of correlation – Application in tree improvement; Path analysis Merits, Demerits, Application in Plant Breeding; Combining ability, types of combining ability –Inbreeding depression and its effects in tree breeding; Mating design in trees and its classification. D^2 statistics – Merits and Demerits; Molecular Diversity Analysis –marker approach – Computation of Data; Adaptation, Types of adaptation, causes of adaptation; Stability analysis of important fast-growing trees; Comparison of stability, combining ability and Heritability analysis.

Practical

Estimation of first and second degree of statistics -mean, median, range, mode, standard deviation and coefficient of variation in tree species-Problems on multiple factor inheritance -

Estimation of genotypic and phenotypic variance in Eucalyptus tree species - Analysis of additive and dominance component of variances in red sanders - Estimation of heterosis in Kadamba trees - Estimation of heritability and genetic gain in Casuarina - Analysis of phenotypic and genotypic correlation in Eucalyptus - Estimation of path analysis in sandal trees - Estimation of GCA and SCA in teak tree species - Studies of different mating design in tree species - Estimation of selection methods in tree species of *Melia dubia* - Line × tester analysis in Eucalyptus tree species - Diallel analysis in *Melia dubia* - Stability analysis in teak tree species - D^2 analysis in Kadamba tree species - Studies of different DNA markers in improving tree species

Suggested Readings

- Nadarajan N. and M. Gunasekaran. 2005. Quantitative Genetics and biometrical techniques in plant breeding. Kalyani Publishers.

Controlled Breeding in Tree Crops 2 (0+2)

Objective

To provide insight into development of hybrids for tree crops and its exploitation for yield improvement through conventional and modern plant breeding approaches

Practical

Pollination and Reproduction in tree crops - Alternation of generation and life cycle -Mode of pollination - Mechanisms enforcing self and cross pollination in tree crops. Methods of survey, exploration and collection of genetic resources of tree crops - Methods of conservation and maintenance of different tree crops. Study of germplasm characterization and evaluation of different tree crops. Study of cataloguing and data storage of genetic resources of tree crops. Study of Cryopreservation techniques of different tree crops – need and utilization. Breeder's kit and its components for tree crops. Pollen morphology - Exine structure of different tree crops. Techniques for pollen collection and storage for different tree crops. Study of pollen viability and sterility for different tree crops. Emasculation and pollination techniques for self-pollinated tree crops. Emasculation and pollination techniques for cross pollinated tree crops. Basic techniques for selfing in tree crops. Basic techniques for crossing in tree crops. Lay out of different yield trials - Observing the experimental plots in tree crops. Assessment of variability parameters (mean, range, PCV, GCV, heritability, genetic advance) in tree crops. Studies on hybrids – Estimation of heterosis in different tree crops. Studies on segregating generations and maintenance of records of different tree crops. Studies on different wild species in tree crops and wide hybridization. Mutagenesis study - physical and chemical mutagens. Polyploidy breeding - Agents for the induction of various ploidy levels. Identification of polyploids in different tree crops. Screening methods – laboratory – field – for specific traits. Screening techniques for biotic stresses in tree crops. Screening techniques for abiotic stresses in tree crops. Floral Biology, Anthesis, Pollination, Selfing and Crossing techniques in Teak. Rosewood, Sandalwood, Eucalypts, *Melia dubia,* Acacia and *Mahogany.*

Suggested Readings

1. Mandal, A. K. and Gibson, G. L. (Eds). (1998). Forest genetics and tree breeding. CBS Publishers and Distributors.

2. Schmidt, L. H. (1997). Tree Improvement Glossary Illustrated glossary of terms used in forest tree improvement. Danida Forest Seed Centre (Technical Note No. 46).
3. Singh, B. D. (2016). Plant Breeding: Principles and Methods. Kalyani publishers.
4. Zobel, B. and Talbert, J. (1984). Applied forest tree improvement. John Wiley and Sons.

Marker Assisted Breeding in Forestry 3 (2+1)

Objective

To provide insight into development of markers in the tree improvement program for identifying the important traits

Theory

Domestication: The Evolution of Crop Plants – Breeding methods- transgenic technology- Molecular markers- Achievement and future prospective in Marker Assisted breeding. Hybridization based markers- Restriction Fragment Length polymorphism (RFLP) techniques and application; PCR based markers –Randomly Amplified Polymorphic DNA marker (RAPD) and its types; Amplified Fragment Length polymorphism (AFLP) principle and their application - Microsatellites marker/ Simple Sequence Repeat maker (SSR) development and application - Development of SCAR and STS marker principle and application. Introduction – SNP marker discovery – methods and tools - whole genome SNP analysis for major gene discovery – Allele mining; Applications of DNA markers in diversity analysis – characterization of plant genetic resources – role of markers in Plant Variety protection. Mapping populations- Linkage Mapping of Molecular Markers and Oligogenes- Mapping of Quantitative Trait Loci - Association Mapping. Marker-Assisted characterization of germplasm and genetic purity- Marker-Assisted Backcrossing- Multitrait Introgression- Innovative Breeding methods for effective use of MAS- Genomic Selection- Phylogenetic Relationships and Genetic Diversity- High-Throughput SNP Genotyping- Bioinformatics Tools and Databases for Genomics Research-Phenomics.

Practical

Analysis of morphological diversity through statistical package like NTSYS - Extraction, quantification and separation of protein markers using SDS-PAGE. Isolation of plant genomic DNA, quantification and quality assessment by agarose gel - PCR using RAPD primers and separation of RAPD fragment using agarose gel electrophoresis. Amplified Fragment Length Polymorphism marker data generation - PCR amplification of genomic DNA using SSR primers -Separation of SSR markers using urea PAGE denaturing gel and silver staining - Finger printing of germplasm lines and seed varietal purity test using SSR markers -Development of SCAR marker from RAPD marker. Phenotyping the mapping population RILs or F_2 using the morphological traits - Genotyping the mapping population RILs or F_2 using the SSR markers - Construction of linkage map using map maker software and QTL analysis. SNP markers data generation and analysis using Real time PCR. Whole genome SNP array data analysis using the Microarray platform. SNP data analysis using pLink software. Marker assisted breeding – MABB studies.

Suggested Readings

1. Ahmar, S., Ballesta, P., Ali, M. and Mora-Poblete, F. (2021). Achievements and challenges of genomics-assisted breeding in forest trees: From marker-assisted selection to genome editing. International Journal of Molecular Sciences, 22(19), 10583.

2. Grattapaglia, D. (2008). Perspectives on genome mapping and marker-assisted breeding of eucalypts. Southern Forests: a Journal of Forest Science, 70(2), 69-75.
3. Nilausen, C., Gélinas, N., and Bull, G. (2016). Perceived acceptability of implementing marker-assisted selection in the forests of British Columbia. Forests, 7(11), 286.
4. O'malley, D. M., and McKeand, S. E. (1994). Marker assisted selection for breeding value in forest trees.

Tissue Culture Applications in Forestry 3 (1+2)

Objective

To provide basic knowledge on the plant tissue culture, techniques, mass propagation, hardening and certification

Theory

Introduction-Concepts and principles. History of Plant tissue culture. Sterilization Techniques-Nutritional requirements for plant tissue culture - Factors affecting plant tissue Culture-Commercial PTC Lab Organization-Micropropagation – applications and limitations. Low cost alternatives in micro propagation. Morphogenesis – direct and indirect, organogenesis and somatic embryogenesis. Callus initiation - establishment and maintenance. Synthetic seeds and applications. Meristem culture and virus elimination - virus indexing methods. Shoot tip culture and *in vitro* clonal Multiplication-Applications. Embryo culture and embryo rescue-applications. *In vitro* fertilization techniques. Ovule, ovary and endosperm culture. Anther and microspore culture - production of Haploids-Protoplast isolation, culture and protoplast fusion - applications - Somaclonal variation - applications. *In vitro* germplasm conservation. Commercial scale micropropagation – Micropropagation of - Neem, Teak, Bamboo, Paulownia, Eucalyptus, Red sanders, Mahogany, Sandal wood, Melia, Casuarina and Gmelina. Micropropagation of rare and endangered plants. Methods for Hardening-Acclimatization-Physiological changes during hardening. Packaging and transport of tissue cultured plants – Domestic and export. National certification system – Guidelines for Accreditation of Test laboratory for virus diagnosis and genetic fidelity testing of tissue culture raised plants and Tissue Culture Production Facility. Classification of secondary plant metabolites. Extraction and quantification methods for secondary metabolites. Plant Cell cultures for secondary metabolite production–steps. Large scale production through bioreactors.

Practical

Laboratory organization - safety regulations and Sterilization techniques for aseptic manipulation. Nutrient stock and growth regulator stock preparation -Culture media preparation. Micropropagation of Neem, Teak, Bamboo, Paulownia, Eucalyptus, Red sanders, Mahogany, Sandal wood, Melia, Casuarina, Gmelina. Inoculation of explants for callus culture - Clonal propagation through meristem culture - Anther and Microspore culture - Embryo culture - Sub-culturing technique for regeneration. *In vitro* and *ex vitro* rooting of tissue culture plantlets - Induction of somatic embryos and synthetic seeds - Establishment of suspensions and viability assay - Determination of cell growth in suspensions - Extraction of secondary metabolites. Phytochemical assay of secondary metabolites - Quantification by HPLC and GC-MS - Testing anti-microbial activity. Induction of hairy roots-medium preparation, strain selection, co-cultivation and maintenance of hairy roots.

NCSTCP-Procedures and Quality analysis by Genetic Fidelity test - Virus indexing in TC plants - A demonstration on hardening and field transfer of TC plants - Visit to commercial tissue culture laboratory - Project preparation for establishment of tissue culture lab.

Suggested Readings

1. Bonga, J. M. and Durzan, D. J. (Eds). (1982). Tissue culture in forestry. Springer Science and Business Media.
2. Bonga, J. M. and Durzan, D. J. (Eds). (2012). Cell and Tissue Culture in Forestry: Volume 2 Specific Principles and Methods: Growth and Developments (Vol. 24). Springer Science and Business Media.
3. Hasnain, S. and Cheliak, W. (1986). Tissue culture in forestry: economic and genetic potential. The forestry chronicle, 62(4), 219-225.
4. Savangikar, V. A. (2004, February). Role of low cost options in tissue culture. In Low cost options for tissue culture technology in developing countries. Proceedings of a Technical Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (pp. 11-15).
5. Tanase, C., Volf, I., Vintu, S., Gradinaru, R., and Popa, V. I. (2013). Potential applications of wastes from energy and forestry industry in plant tissue culture. Cell. Chem. Technol, 47(7-8), 553-563.
6. Thorpe, T. A. (1983). Biotechnological applications of tissue culture to forest tree improvement. Biotechnology Advances, 1(2), 263-278.

Reproduction Biology of Tree Crops 3 (2+1)

Objective

To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding and sex expression

Theory

Reproductive Biology – Introduction – Concepts – Importance – Mode of reproduction – types – Tropical trees – Temperate trees – Tree characteristics - growth and development (both vegetative and reproductive) - Floral morphology and types of flowers- floral initiation and breeding systems. Floral Measurement and prediction of Flowering-Juvenility and vernalization - Floral diversity and pollination. Mode of pollination – Cross pollinated and self-pollinated tree species. Mechanisms and significance - Pollination syndromes and their evolution; Plant – Pollinator systems, Diversity of pollination syndromes in selected plant families. Sex expression, monoecy, dioecy and its evolution. Environmental effects on sex expression. Floral attractants and rewards; Biology of floral and extra floral nectaries; Examples of plant insect interactions involving pollination. Floral characteristics of the main pollination syndromes- Mating system dynamics in Forest trees – Factors affecting different mechanisms – Mechanisms promoting high levels of Out-Crossing – self incompatibility – Factors leading to unusually low levels of out crossing – Factors that prevent or limit self-fertilization. Environmental effects on sex expression - Plant-pollination interactions, Pollinator energetic and nectar production, Pollen travel within and between trees – pollination efficiency, reproductive efficiency, Distance of pollen travel, pollen transport and pollen viability. Fertilization in hard wood

trees – Double fertilization – Seed formation in angiosperms - fertilization in soft wood trees – Cone formation in softwood trees. Seed dispersal – Benefits of seed dispersal – types of dispersal – consequences of seed dispersal – Gene flow- Barrier to gene flow – Gene flow between species (Genetic pollution) – Models of gene flow – Gene flow mitigation.

Practical

Sex expression in forest trees – Out crossing mechanisms in forest trees – Measurement of pollen flow in wind – pollinated and insect-pollinated species – Pollen viability – Hanging drop techniques and fertility – Seed dispersal mechanisms – wind – water.

Suggested Readings

1. Dattee, Christian Dumas and Andre Gallais.1992. Reproductive Biology and Plant Breeding. Springer
2. Khosla PK. 1981. Advances in Forest Genetics. Ambika Publ., New Delhi
3. Mandal AK and Gibson GL. (Eds) 1997. Forest Genetics and Tree Breeding
4. Ramawat Kishan Gopal, Mérillon Jean-Michel, and Shivanna K R. 2014. Reproductive Biology of Plants. CRC Press.
5. Shivanna K R and Rangaswamy N S.1992. Pollen Biology a Laboratory Manual. Springer-Verlag. New York
6. Zobel BJ and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley andSons
7. Zobel BJ, Wyk GV and Stahl P. 1987. Growing Exotic Forests. John Wiley and Sons.

Forest Genetic Resources 2 (2+0)

Objective

To impart knowledge on forest genetic diversity, biodiversity assessment, global conservation initiatives and conventions related to conservation of forest genetic diversity

Theory

Genetic diversity and differentiation: definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation. Molecular approaches for assessing genetic diversity; isozymes, biochemical makers and molecular markers: principles, importance and relevance. Biological diversity: concept and levels. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts. Effects of sampling on genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Population size and genetic variability – Genetic variation in natural population: data, models and hypotheses – Inbreeding depression -Changes genetic diversity over time – Effects of logging and other forms of harvesting - Forest Fragmentation and environmental population - Gene flow in forest trees – Methods of estimating gene flow – Conservation methods - Threats to *in situ* and *ex situ* Genetic Conservation. Conservation of genetic diversity and invasive species. Global and local initiations for biodiversity conservation. Law and policies. Criteria and indicators for the conservation of genetic diversity. Methods for maintenance of conservation: gene banks, arboreta,

botanical gardens, breeding populations as repositories of gene conservation. Rare, threatened biodiversity, endangered and endemise plants (IUCN). Global and local initiations for Biodiversity conservation. Concept of island biogeography. Managing corridors and natural habitat fragments. Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora, tourism impacts and urbanization of rare plants. Implications of rarity. Dunkal draft – need for trade agreement – TRIPS, TRIMS – IPR - WTO – TRIPS and Patenting Issues – The Protection of Plant Varieties and Farmers' Rights Act 2001 - National Biodiversity Act 2002 – Biopiracy – CITES – Cartagena Protocol on Biosafety - Biosafety protocol.

Suggested Readings

1. Bebarta, Kailash Chandra. 2002. Planning for forest resources and bio-diversity management principles, organization and methodology. Concept publishing company, New Delhi, India. ISBN 81-7022-879-4.
2. Groom, M. J., Meffe, G. K. and Carroll, C. R. 2006. Principles of conservation biology. Sinauer Associates Inc. USA.
3. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press. P. 1140.
4. Mandal, A. K. and Gibson, G. L. (Ed.). 1997, Forest Genetics and Tree Breeding. CBS.
5. Kotwal, P.C. and Banerjee, Sujoy. 2004. Biodiversity conservation-in managed forests and protected areas. Agrobios (India). 81-7754-119-6.
6. Parthiban K.T., Krishnakumar, N. and P.S Devanand. 2020. Tree Breeding - Theories and Techniques. Scientific Publishers, P 391.

Tree Seed Orchard 3 (2+1)

Objective

To develop understanding among students about tree seed orchards

Theory

Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply of superior seed. Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones. Seed orchard: need, evolving seed orchards, containerized seed, hybrid and research seed orchards; first, second and advanced generation seed orchards. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortet age and its effect on seed production. Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield. Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

Seed orchard - Visits and study of seed orchard designs - Estimation of overlap in flowering among genotypes - Study of inter and intra-clonal variation in floral, seed characters - Effect of

girdling on flowering. Plant growth regulator application for flower induction - Pollen viability/ fertility - Assessment of pollen dispersal. Supplemental mass-pollination - Effects of foliar application of fertilizers on seed set - Estimation of genetic parameters for a few traits - Estimation of parental balance.

Suggested Readings

1. Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No. 34.
2. Fins L, Friedman ST and Brotschol JV. 1992. Handbook of Quantitative Forest Genetics.
3. Khosla PK. 1981. Advances in Forest Genetics.
4. Mandal AK and Gibson GL. (Eds). 1997. Forest Genetics and Tree Breeding. Ambika Publ., New Delhi. CBS.
5. Nanson A. 2004. Genetics of Forest Tree Breeding. Agronomic Press
6. Surendran C, Sehgal RN and Parmathama M. (Eds). 2003. A Text Book of Forest Tree Breeding. ICAR.
7. Wright JW. 1976. Introduction to Forest Genetics. Academic Press.
8. Zobel BJ and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley and Sons.

Clonal Forestry 2 (1+1)

Objective

To learn the state-of-the-art clonal technology and its application in operational plantation development program

Theory

Clonal Forestry – definition – History of clonal forestry- Basic concepts in clonal forestry – Strategies for clonal forestry for higher productive potential – advantages of clonal forestry constraints – Selection of Plus Trees – Propagation methods- auto and hetero propagation methods – rooting of cutting, grafting, layering, budding- micro-clonal propagation methods. Potting media – components of potting media - physical and chemical characteristics of potting media – peat, vermiculite, perlite, styrofoam, soil, sand - Plant growth substances – Auxins – cytokinins – gibberellins – ethylene – preparation of powder and liquid formulations –Applications in clonal multiplication. Juvenility and maturation, rejuvenation and maintenance, regulation of phase changes, markers of phase changes. Breeding strategies using vegetative propagation- selection and breeding for extreme genotypes. Physiological research for higher productivity of clonal forest. Field design, testing and evaluation of clones. Genetic gains from breeding with clonal option. Clonal conservation approaches- management of populations for genetic diversity and gain - Designs of clonal evaluation – Amplified clonal test. Hi-tech Nursery – Components and Characters. Mini clonal technology – Clonal mother garden – Care and Management of mother garden – Multiplication technology for commercially important species - Clonal plantation establishment- management strategies – Problem and constraints in clonal forestry – Development of QPM through clonal plants - Role of industries in clonal production.

Practical

Clonal forestry – Hi-tech nursery – Components and characters – Biological components – Clonal genetic resources – Commercially important species – Mother Garden establishment – Care and management – Irrigation – Fertilization. Physical components - Propagation Chambers – Mist chamber – Green house – Cost of establishment – Technology component – Mini clonal technology – Design and Development – Potting media – Hardware's – Growth regulators – Root trainer technology. Visit to industries and other nurseries involved in clonal production – Economics of clonal production.

Suggested Readings

1. Ahuja and Libby. 1986. Clonal Forestry. Martinus Nijhoff Publishers, Dordrecht.
2. Hartman, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 1997. Plant Propagation –Principles and Practices. Prentice- Hall of India Pvt. Ltd., New Delhi. P 770.
3. Parthiban K.T. 2024. Hi-tech Nursery – Components and Characters. Technical Bulletin, TNAU Publication
4. Parthiban K.T., Paramathma, M., and Neelakantan, K.S. 2004. Clonal Forestry. TNAU Publications, Coimbatore. Pp: 209.

Plant Biochemistry 2 (1+1)

Objective

To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid-base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver-Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO_2 fixation, regulation of photosynthesis. Metabolism of carbohydrates -glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0-7167-8724-5.
2. Berg Jeremy M, Stryer Lubert, Tymoczko John and Gatto Gregory. Biochemistry.
3. Buchanan Bob B. Biochemistry and Molecular Biology of Plants. Wilhelm Gruissem, and Russell L. Jones.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer David T. An Introduction to Practical Biochemistry.
6. Rao Beedu Sashidhar and Deshpande Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam S and Manickam A (2009) Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B, Krishnaveni, S and Parvathi, K (2004) Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet Donald and Voet Judith. Biochemistry.
10. Wilson K and Walker, J M (2000) Principles and techniques of Practical Biochemistry

Research Methodology 2 (1+1)

Objective

To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey-based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

Statistical Packages for Data Analysis 1 (0+1)

Objective

To develop the art of data collection, processing, analysis and interpretation to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in SYSTAT for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, SYSTAT file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam AK and Gupta VK (1979) Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse V G and Sukhatme PV (1967) Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G (1994) Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman K and Rugmini P (1990) Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

D) Wood and NWFPs product development and utilization

1. Wood Identification (0+2)
2. Wood Physics and Chemistry (2+1)
3. Forest Products Laboratory Techniques (0+2)

4. Wood Seasoning and Preservation (1+2)
5. Wood Working and Carpentry (0+2)
6. Composite Wood Technology (2+1)
7. Non-Wood Forest Products and Value Addition Technology (2+1)
8. Ethnobotany, Medicinal and Aromatic plants (2+1)
9. Certification of Forest Products (2+0)
10. Plant Biochemistry (1+1)
11. Research Methodology (1+1)
12. Statistical Packages for Data Analysis (0+1)
13. Internship with tree breeding and biotechnology-based institutions/industries (0+2)

Wood Identification 2 (0+2)

Objectives

1. To equips students with knowledge of macro and micro-structure of softwoods and hardwoods and their relation with properties of wood
2. To exposes students to use of anatomical features of wood in timber identification and classification

Practical

Planes of wood and physical characteristics of important woods. Identification of different types of cells and tissues. Anatomical studies of soft and hard woods. Hand lens features and identification of wood - soft wood and hardwood, sapwood and heartwood specimens. Maceration, staining, slide preparation and measurement of dimensions of woody tissues. Anatomical studies of reaction wood. Ultrastructures and their interpretation. Measurement of fibril angle and tissue proportions. Microscopic features of Bamboo, Palmyrah, Cane and Coconut. Classification of timber using dichotomous keys. Modern timber identification techniques. Microscopic features, slide inspection of twenty-five species characteristics. Morphological observations on import timber species of common occurrence for architectural patterns of habit, and buttress.

Suggested Readings

1. Meier, E. 2015. Wood identifying and using hundreds of woods worldwide. Wood database.
2. Porter, T. 2004. Wood identification and use. Guild of Master Craftsman, UK.
3. Purkayastha, S K. 1982. Indian woods: Their identification properties and uses. Controller of Publication
4. Ratura and Juneja, K.D.S.1971. A Handbook for field identification of fifty important timbers of India. Manager of Publications.

Wood Physics and Chemistry 3 (2+1)

Objectives

1. To impart knowledge about the physical and chemical properties of wood, cell wall constituents and wood extractions

2. To study the industrial utilization of wood extractives

Theory

Density and specific gravity. Variation in density of early and late wood constituents. Effect of growth rings on density. Pith to peripheral density variations. Different modes of presentation in relation to moisture content-wood water relationship and moisture estimation in wood. Physical properties of wood as influenced by moisture content. Specific gravity of wood substance. Anisotropy in Wood. Dimensional changes on heating green wood. Effect of dry and wet heat and heating in presence or absence of air on strength and dimensional stability. Thermal expansion, specific heat, thermal insulation value, ignition of wood and fuel value. Thermal conductivity and diffusivity. Change of temperature in wood under heating. Effect of moisture on thermal properties. Thermal properties of wood composites. DC and AC characteristics of wood-electrical conductivity, effect of moisture content and temperature. Activation energy associated with electrical conduction. Voltage breakdown strength. Dielectric properties of wood under alternating current and electro. Dielectric strength - dielectric constant and loss. Power factor - magnetic field conditions, effect of specific gravity, moisture content, temperature and extractives. Principles of induction and dielectric heating. Piezo-electric properties of wood and its applications. Sound transmission and acoustics in buildings. Speed of sound- wave resistance - coefficient of sound absorption - Response of defects to stress waves in timber-acousto-ultrasonics based non-destructive evaluation techniques. Wood chemistry-introduction-present status-scope of wood chemical Industry-Chemical composition of cell wall. Carbohydrate polymers - holo cellulose, cellulose, hemi-cellulose and other minor polysaccharides. Lignin and extractives. Chemistry of bark, extractives, hemi celluloses, cellulose, lignin and inorganics. Distribution of chemical components in the cell wall. Components of cell. Volatile oils and extractives. Chemical relativities of cellulose, hemicellulose and lignin. Cellulose derivatives and their applications. Lignin based products. Hydrolysis and fermentation of ligno cellulosic materials. Pyrolysis and gasification of wood. Bioactive components from wood. Eco-friendly dyes from bark and wood. Isolation of extractives from wood and bark. Separation of secondary metabolites. Industrial utilization of wood and bark extractives such as natural rubber, resin and turpentine from pines, tannins, pharmacologically active metabolites and future directions for their utilization.

Practical

Properties of wood, electrical, acoustic. Sonic and ultra-sonic properties. Determination of strength properties, specific gravity, F.S.P. from shrinkage and sorption. Determination of thermal conductivity, dielectric constant, permeability of wood to air. Extraction of cellulose, hemicellulose, lignin, extractives and ash content of wood. Determination of calorific value of different wood species and ligno cellulosic wastes. Making charcoal and briquettes. Wood chemical isolation through chromatography. Isolation of pure chemical constituents using thin layer and column chromatography. Estimation of turpentine and resin. Isolation of polysaccharides and characterization of mono sugars. Estimation of oil from sandal wood. Extraction of dyes from different wood species. Visit to natural dye industry and study its properties.

Suggested Readings

1. Franz, F.P, Kollmann, Kuwnzi, E and Stamm, A.J. 1975. Principle of wood science and technology. Wood based material. Vol. II Springer-Verlag, Berlin, Heidelberg.

2. Meyland, B.A and Butterfield, B.G (Eds). 1972. Three-dimensional structure of wood: a scanning electron microscope study. Syracuse University Press.
3. Roger, R.M (Ed). 2013. Handbook of wood chemistry and wood composition. 2nd Ed. CRC Press.
4. Rowell, R.M. 1984. The chemistry of solid wood (advances in chemistry series). American Chemical Society.

Wood Seasoning and Preservation **3 (1+2)**

Objective

To understand the importance of wood seasoning and preservation for utilizing secondary timber for multipurpose use.

Theory

Wood water relationship, absorption behavior and wood drying, Refractory and non-refractory behavior of wood, Wood seasoning, types- air, kiln and special seasoning methods like steaming, chemical, high temperature drying, vacuum drying and water conditioning. Defects of timber - natural, seasoning defects, defects due to external agencies, machining defects. Effect of defects on utilization. Detection and diagnosis of discoloration and decay in wood: decaying agencies - fungi, insects and borer. Durability of timbers. Mechanism of wood preservation – kinds of wood preservatives - Advantages and safety concern of wood preservatives, fire retardants. Graveyard test and anti-fungal activity of wood. Biopreservation. Methods of application of wood preservatives – Non pressure methods – Brushing – Steeping – Hot and cold bath process – Diffusion process – Momentary dip process – Sap displacement method – Boucherie method – Pressure method – Full cell process – Empty cell process.

Practical

Determination of moisture content and swelling coefficients of different woods. Visit to timber depot/saw mill to study the stacking methods and various defects in wood. Visit to Wood seasoning unit to study the various types of seasoning methods and Safety aspects. Exercise on fixing seasoning schedule for timbers under steam heated kiln and FRI solar heated kiln seasoning method. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters. Visit to wood testing laboratories. Laboratory methods for testing efficacy of wood preservative against fungi and termite. Study on the environmental health and safety aspects of wood preservatives. Exercise on non-pressure methods of application of preservatives for plantation timber - End coating - Sap Displacement Method and Boucherie process. Exercise on Full cell process techniques. Study of seasoning and preservative treatments for fast growing tree species. Study of seasoning and preservative treatments for lesser known tree species. Conducting Grave yard test to evaluate natural durability of plantation and imported timber.

Suggested Readings

1. FAO. 2007. Wood preservation manual. International Book Distributor
2. Hunt GM. 1967. Wood Preservation. 3rd edn. McGraw-Hill Book Company.
3. Purushotham A, Pande JN and Jadhav. 1959. Wood Preservation in India. Manager of Publications.

Forest Products Laboratory Techniques 2 (0+2)

Objectives

1. To acquaint the students to commonly used techniques in laboratory
2. To expose the students to the practical aspects of laboratory techniques employed in forest products

Practical

Introduction to laboratory techniques - Applicability of laboratory techniques in Forest Products Lab - Practicing of machine vision techniques - Morphometric and anatomical changes during wood Seasoning and Preservation - Wood and non-wood product sampling, drying and storage. Estimation of extraneous components of wood. Analysis of volatile compounds. Estimation of chemical composition of wood samples (Hardwoods, softwood and other lingo cellulosic material) and ash. Separation of components by column, paper, and thin layer chromatography. HPLC techniques. Determination of strength properties of paper and wood composites.

Suggested Readings

1. Furr A K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Meyland BA and Butterfield BG. 1972. Three-Dimensional Structure of Wood: A Scanning Electron Microscope Study. Syracuse University Press.

Composite Wood Technology 3 (2+1)

Objective

To impart knowledge regarding the processing technology for wood composites and modified woods

Theory

Introduction to wood modification, its need and scope, chemical modification of wood (Acetylation, reaction with isocyanates, acetates, ethers, epoxides, etc.). Wood impregnation and compregnation, heat stabilization, compressed wood, wood densification. Wood plastic composites-polymer used-manufacturing process. Scope and importance-veneer production process-rotary cutting and slicing-types of veneer and their uses-advantages of veneered panels in wood products-veneer jointing – finger joints -veneer grading-storage and handling of veneer. Production, properties, performance and application of Glue Laminated Timber (GLT), Structural Composite Lumber (LVL, PSL, LSL). Production, properties, performance and application of plywood, Particle board, Sandwich board, Core board, Flake board, Fibre board (LDF, MDF, HDF) and Nano Composites. Wood adhesives - types, characteristics and their applications. Scope and merits of laminated wood-choice of species and dimensional stability consideration, multispecies laminates-types of Laminates-Matte-finish laminate, textured laminate, gloss-finish laminate, metallic laminate, PVC-finish laminate, acrylic-finish laminate and exterior laminate. Laminated wood from bamboo and bamboo laminates. Acoustic panels from laminated wood densified laminate panels. Bamboo composite wood-based Industries. Bamboo Mat based Products-Bamboo Mat Board (BMB), Bamboo Mat Veneer Composites [(BMVC) and Bamboo Mat Corrugated Sheet (BMCS), Bamboo mat tray. Bamboo strip-based products - Bamboo flooring tiles and high density transport flooring.

Practical

Preparation of veneer and testing the quality. Visit to plywood industry, particle board and hard board industry. Plywood preparation and Accelerated ageing test on plywood. Preparation of particle board and hard board and conducting accelerated ageing test, glue shear strength and internal bond strength test. Assessment of wood quality in plantation grown timber for the production of plywood and particle board. Visit to Wood Plastic Composite manufacturing unit, wood plasticization unit and studying the plasticity of wood. Determination of linear and volumetric shrinkage of composite wood. Study of different grades of composite wood, nano composite preparation and commercial utilization. Assessment of different grades of plywood. Evaluation of penetrability of preservatives in composite wood. Study on wood modification technology. Study on Bamboo Mat Based Products-BMB, BMVC and BMCS. Study on Bamboo Strip Based Products - Bamboo flooring tiles and high density transport flooring. Visit to Laminated bamboo furniture industry.

Suggested Readings

1. Antole A. Klyosov, 2007. Wood Plastic Composites. Wiley-Interscience, 1st edn.
2. Ansell Martin P, 2015. Wood Composites. Wood head publishing.
3. Jin Kuk Kim, 2011. Recent Advances in the Processing of wood-plastic composites. Springer publications.
4. Papadopoulos Antonios N, 2020. Advances in Wood Composites.
5. Roger M and Rowell, 2005. Handbook of Wood Chemistry and Wood Composites. Published by Taylor and Francis.

Non-Wood Forest Products and Value Addition Technology 3 (2+1)

Objective

To make students understand and learn about the different non wood Forest Products and their scientific extraction, processing and disposal

Theory

Non-Wood Forest Products - Present status, demand and supply, classification, distribution and marketing. Role of tribal co-operative societies in NWFPs. Recent trends in NWFP. Quality assessment of important products and their methods for storage. Important non-wood forest products industries. Gums – Occurrence, origin, functions, kinds, properties, tapping methods, factors affecting gum formation, scientific management, collection, processing and storage -value addition - industrial application- uses. Resins –occurrence, origin, kinds, properties, tapping methods, processing and storage, uses, industrial application and value addition. Lac -different species, distribution, improved method of cultivation, scientific management, collection, processing and storage, value addition and uses. Shellac - cleaning and grading, properties, value addition and their uses. Tannins - Definition, species - nature and kinds, occurrence, function, collection, extraction, processing, value addition and uses. Dyes - definition, species, types, extraction, processing value addition and uses. Cutch and Katha - species, extraction methods, processing value addition and uses. Essential oils - species, types, extraction process, value addition and commercial applications -Tree Borne Oil seeds (TBOs) tree species, collection, extraction methods and uses. Drugs species – extraction process – industrial applications. Animal products – honey and wax

-collection, processing, storage. Silk – silk farming – silk types, mulberry –types, distribution, improved method of cultivation, collection and storage, value addition and uses. Mineral products - other miscellaneous products.

Practical

Visit to nearby forests to study important NTFP yielding plants. Visit to non-wood forest products-based industries. Visit to agave extraction unit and study the fiber extraction process. Visit to Sericulture unit to study Silk production technology. Visit to Essential oil extraction unit and study the different extraction methods. Study of tans and visit to tannin industry. Study of dyes and visit to dye extraction unit and their sources. Visit to biodiesel production and study the trans-estrification process. Visit to Herbal Gardens and herbaria to study medicinal plants. Quality assessment of important NWFP and their methods for storage. Study of plants yielding drugs, spices, wild edible plants, poisons and bio-pesticides and their collection from nearby forests. Visit to a tribal village involved in collection, processing and sale of NTFPs. Utilization of various NWFP and their scientific management for processing, value addition and disposal.

Suggested Readings

1. Linskens H F and Jackson J F. 1991. Essential oils and waxes (Ed.). Springer-Verlag Berlin Heidelberg.
2. Mathe A. 2015. Medicinal and aromatic plants of the world-scientific, production, commercial and utilization aspects. Springer, Netherlands.
3. Panda H. 2005. Hand book on specialty gums, adhesive, oils, rosin and derivatives, resins, oleoresins, katha, chemicals with others natural products. Asia Pacific business press. Inc.
4. Panshin A J, Harrer E S and Bethel J S. Forest products, their sources, production and utilization.
5. Shackleton S, Shackleton C and Shanley P. (Ed.) 2011.Non-timber forest products in the global context. Springer-Verlag Berlin Heidelberg.

Wood Working and Carpentry 2 (0+2)

Objective

To make students to understand and learn about the wood working and carpentry skills

Practical

Identify timber/ wood and apply measuring, marking and testing instrument and holding and supporting hand tools following safety precautions. Work on various saws and portable power saw machines for Ripping, cross cutting, Oblique sawing and curve cutting. Analyze the surface finish with exact sizing by planning operation - Identify and apply various shaving tools or portable power planning machine. Identify and apply various paring tools and analyze and choose the positioning and employ holding device for chiselling. Identify and classify various types of joints, analyze and prepare correct joint at correct position, related with strength and appearance. Make small wooden job as per drawing with schedule sizes of timber or alternatives of timber. Analyze and identify various carving tools and convert a wooden block/ piece into a decorative article. Demonstrate preservation of wooden item through surface finishing with various processes such as painting, polishing, varnishing etc. Demonstrate ripping, cross cutting, pedestal grinding, Tenon and mortise

machine. Demonstrate different operations on Sanding machine. Prepare various roof truss, door and windows frame and shutters. Check, identify, analyze and repair the wooden job.

Suggested Readings

1. Bates, D. (2013). Carpentry and Joinery Book 1. Routledge.
2. Brett, P. (2012). Carpentry and Joinery Book Two: Practical Activities. Oxford University Press-Children.
3. Goring, L. (2018). Manual of First and Second Fixing Carpentry. Routledge.
4. Wheeler, C. G. (2018). Wood-Working for Beginners. BoD–Books on Demand.

Ethnobotany, Medicinal and Aromatic plants 3 (2+1)

Theory

Definition and scope of ethno-botany. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic – people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, *etc* Methods and tools in Ethnobotanical studies. Ethnobotany of tribals in Southern India. Traditional Botanical Knowledge- concepts.

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, Champaka, Sandal, Cinnamum spp., *Bursera delpechiana* - botany, climate and soil requirements, planting cultural and manorial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and Karnataka - history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like atropa, cinchona, rauvolfia, opium, sandal, acorus, cannabis, digitalis, *Strychnos nux-vomica, Aconitum,* Neem*, Dioscorea, Costus, Solanum* etc. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia, Sterospermum colais*, *Plumbago zylanica*, *Tinospora cordifolia*, *Kaemferia glanga*, *Indigofera tinctoria, Morinda citricifolia and Phyllanthus neeruri.* Conservation packages for the medicinal plants collected in wild.

Practical

Ethnobotanical studies of the important plants from the following families: Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Field visit to different tribal regions to gain ethno-botanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Suggested reading

1. Atul, C.K. and Kapur, B.K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.
2. Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.
3. Cunningham, A. 2014. Applied Ethnobotany: People, Wild Plant Use and Conservation. Taylor and Francis.
4. EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction
5. Ethnobotany. Principles and applications. (1997). C. M. Cotton. John Wiley and Sons Ltd. 424p.
6. Gunther, E. (1975). The essential oils. Robert, K Krieger Pub. Co., New York.
7. Jain, S.K. 2010. Manual of Ethnobotany (2nd edn). Scientific Publishers, India, 242p.
8. Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672p.

Certification of Forest Products 2 (2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Program for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Suggested readings

1. Bass, S. 1996. Introducing forest certification. A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest Institute, Discussion Paper 1. 30p. Details available at: http://www.giz.de/Themen/de/dokumente/en-d28-inenpenennt-certification-verification-forest-manage.pdf.
2. Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
3. Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
4. Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

Plant Biochemistry 2 (1+1)

Objective

To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid-base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver-Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO_2 fixation, regulation of photosynthesis. Metabolism of carbohydrates -glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry, 7th Ed. Wiley Eastern Ltd. ISBN:0-7167-8724-5.
2. Berg Jeremy M, Stryer Lubert, Tymoczko John, Gatto Gregory. Biochemistry.
3. Buchanan Bob B, Gruissem Wilhelm and Jones Russell L. Biochemistry and Molecular Biology of Plants.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer David T. An Introduction to Practical Biochemistry.
6. Rao Beedu Sashidhar and Deshpande Vijay Experimental Biochemistry: A student companion.

7. Sadasivam, S and Manickam A (2009) Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan B, Krishnaveni S and Parvathi K (2004) Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet Donald and Voet Judith. Biochemistry.
10. Wilson K and Walker J M (2000) Principles and techniques of Practical Biochemistry

Research Methodology 2 (1+1)

Objective

To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey-based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

Statistical Packages for Data Analysis 1 (0+1)

Objective

The art of data collection, processing, analysis and interpretation will be developed to the translate simple data in to scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in SYSTAT for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, SYSTAT file, database file

and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.
2. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
3. Panse, V. G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
4. Petersen Roger G. (1994) Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

Forest Resource Management and Utilization

1) RS and GIS Application for Forest Resource Management (2+1)
2) Ecosystem Services and Valuation of Forest Resources (2+1)
3) Entrepreneurship in value chain improvement of Forest Resources (2+1)
4) Joint Forest Planning and Management (1+1)
5) Climate Change Mitigation (2+1)
6) Ecotourism (2+1)
7) Restoration of Degraded Lands (2+1)
8) Urban Ecology and Environment (2+1)
9) Plant Biochemistry (1+1)
10) Research Methodology (1+1)
11) Statistical Packages for Data Analysis (0+1)
12) Internship with Forest Business Unit/RS-GIS Company or Organization (0+2)

RS and GIS Application for Forest Resource Management (2+1)

Theory

Remote sensing types, Digital data formats, Image processing techniques, Electromagnetic spectrum and its interaction with atmosphere and surface, Creation of False Color Composites (FCC). Geometric and Radiometric Errors of images, Geometric and Radiometric corrections: contrast enhancement, Linear contrast stretch, Histogram equalization, Filtering, Image fusion technique, Vegetation Indices, Supervised and Unsupervised Classification. GIS and its components, Raster and vector data models, Visual image interpretation, database management system(DBMS), Essential map elements, Coordinate System and Projection, Attribute data and thematic mapping. Geographical Positioning System (GPS), GPS accuracy, Segments of GPS.

Practical

Introduction to GIS Software, Satellite data handling, Geo-referencing. Creation of False Color Composite. Image processing techniques: Contrast enhancement, Linear contrast stretch, Histogram equalization, Filtering, Image fusion technique, Vegetation Indices. Projection of digital data. On screen digitization with QGIS. Spatial and attribute data in maps in DBMS. Handling GPS receiver.

Suggested reading

1. Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London
2. Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA: ESRI
3. Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351
4. Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press
5. Lillesand, T.M. and Kiefer, W. R. (1994). Remote sensing and Image Interpretation, Fourth edition. John Wiley and Sons, Inc., USA
6. Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS and LUP, Nagpur.

Ecosystem Services and Valuation of Forest Resources 3 (2+1)

Theory

Ecosystem Services (ES) basics, importance, history of ES and natural capital, Classification of ES-provisioning, regulating, supporting and cultural services and their status and changes, drivers of change of ecosystem services, international conventions and charters on ES-Inter-Governmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Millennium Ecosystem Services (MEA) assessment - an overview. Linkages among biodiversity, ecosystem services and human wellbeing. Quantification of ecosystem services-direct and indirect approaches. Ecological Economics: Valuation of ES, need for valuation. Use values and Non-Use values direct value, indirect value, optional value, bequest value, existence value. Valuation Methods-Market price-based approach such as stumpage value method, productivity and cost-based approaches such as replacement cost method and surrogate market and stated preference approaches such as stumpage value method, Hedonic Pricing Method, Contingent Valuation Method, Travel Cost Method, etc., Case studies in India and abroad. Challenges in valuation of ES. Governance and policy issues in ecosystem services, Payment for ecosystem services (PES), mechanisms of benefit sharing, eco-certification, Certification process in agro-forestry based carbon projects and carbon finance. Geographic Indications, Forest Stewardship Council, Landscape labelling. National and International initiatives in PES and recent policy and programs.

Practical: Valuation methods - direct and indirect methods, Valuation of standing timber, Case studies of PES in India and Abroad, Case studies on certification and geographical indications.

Suggested Readings

1. Alavalapati JRR and D Evan Mercer. 2004 Valuing Agro-forestry Systems: Methods and Applications. Kluwer Academic Publishers.

2. Huxley P. 1999. Tropical Agro-forestry. Blackwell.
3. Jain SK and Singh P. 2000. Economic Analysis of Industrial Agro-forestry: Poplar (*Populus deltoides*) in Uttar Pradesh (India). *Agro-forestry Systems*.
4. Jeffers JNR. 1978. An Introduction to System Analysis with Ecological Application. Edward Arnold.
5. Jose S. 2009. Agro-forestry for Ecosystem Services and Environmental Benefits: An Overview. *Agro-forestry Systems*.
6. Nair PKR. 1993. An Introduction to Agro-forestry. Kluwer, Netherlands.
7. Paulo ELD and Nunes. 2014. Handbook on the Economics of Ecosystem and Biodiversity. E-book.
8. Sander J, Nicolas D and Hans K. 2014. Ecosystem Services: Global Issues and Local Practices. First Edition. Elsevier Publications.
9. Schroth G and Sinclair F. 2003. Tree Crops and Soil Fertility: Concepts and Research Methods, CABI, Wallingford, UK.
10. Young A. 1997. Agro-forestry for Soil Management. Second edition. CABI, Wallingford, UK.

Entrepreneurship in value chain improvement of Forest Resources 3 (2+1)

Theory

Forest resources as Agri-business option for rural development, SWOT analysis of forest resource entreprise, Demand and supply forecasts in forest resources, Price determination and price discovery in forest resources, Collection, processing and value addition of forest resources, Value chain analysis (VCA) of forest resources, market dynamics and trade mechanism in forest resources, Cost benefit considerations in forest resources production, Economics and marketing of forest resources, Cooperative societies, industries, NGOs and Government organizations in strengthening forest based livelihood.

Practical

Field based value chain study of any important forest resource. Case study on entrepreneurship of any cooperative, NGO, society, industry.

Suggested Readings

1. Charles W, Hill L and Steven L McShane, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
2. Girish B and S S Inamati. Forest Business Management by Shahapurmath. Satish Serial Publishing House
3. Koontz H and Weihrich H, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
4. Massie J L, 1995, Essentials of Management, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Prasad L M, 2005, Principles and Practices of Management, Sultan Chand and Sons Educational Publishers, New Delhi.
6. Rao V S B, and Narayana P S, 2004, Principles and Practices of Management, Konark Publishing Pvt. Ltd. New Delhi.

Joint Forest Planning and Management 2 (1+1)

Theory

Concept of JFM. Definition. Meaning what is your idea of JFM, CFM? Learn Definition of JFM in state and national JFM guidelines (latest versions): what is common to all? -what is different? -if different, why? -what is specific to your own state?

Concept-why from the conventional management of forests did JFM evolve? -what was the status of: protection, harvest and provision of benefits in: 1. conventional forest management 2. Social forestry.

JFM Key Principles What is management of resources? -what are the resources available to be managed in the forests? -why the resources are to be managed? -what is the difference of carrying capacity of forests with canopy? -visualize canopy wise availability of resources. (Between 0.1 and 0.4, more than 0.7) 1.2 what is joint management of resources.

Legal position-what are the criteria to identify target areas? Area coverage? Community? -what will be the time span to be earmarked for JFM? -Why? - Figure out stages of JFM program period. -what is the functional role of FD and local people? - What is the legal frame that endorses the above identified factors? 1 hour

Scope and limitations-what will be the measures to fill gaps? -what will be possible limitations? Community Forestry: Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry. Forests and man: Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural Environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups. Social Forestry for fodder production, fuel wood, production, leaf manure, timber production.

NTFPs Joint Forest management: concept, legislation, rules, importance Joint Forest management: concept, legislation, rules, importance. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMS, FDCS. VFCS, CBOS. NGOS and co-operative societies Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies.

Practical

Joint Forest management: concept, legislation, rules, importance Joint Forest management: concept, legislation, rules, importance. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMS, FDCS. VFCS, CBOS. NGOS and co-operative societies Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint

Forest management: concept, legislation, rules, importance. Case studies of JFM implementation-problems and prospects, Microplan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies. Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups. Social Forestry for fodder production, fuel wood, production, leaf manure, timber production, PRA exercises. Visit to village to study the community forestry components- Community reserve, organizational set up and administrative procedures in a social forestry (SF) Range, Microplan Preparation-Field visit to a JFM operational area and conduct PRA surveys. Afforestation techniques and social forestry.

Suggested reading

1. Balakathiresan, S. (1986). Essentials of forest management, Nataraj Publishers, Dehradun.
2. Bullock, R. C. L. and Hanna, K.S. (2012). Community Forestry Local Values, Conflict and Forest Governance. Cambridge University Press.
3. FAO (1984). Forestry extension, making it work, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
4. Jha, L.K., Sen P. K. and Sarma, A.P.H. (2008). A Manual of Forestry Extension Education, Published by VEDA MS, P. 386 p.
5. Jalihal, K.A. and Veerabhadraiah, V. (2007), Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.
6. Gunter, J. (Ed.). (1973). The Community Forestry Guidebook (http://www.forrex.org/ sites/ default/ files/ forrex_series/FS15.pdf).
7. Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R and Belcher, B. (2007). Communities, Forests and Governance: Policy and Institutional Innovations from Nepal. Adroit Publishers, New Delhi, India.
8. Roy, S.B. and Chatterjee, M. (1994). Joint Forest Management. Inter India Publications Tiwari, K.M. (1983). Social forestry for rural development. International Book Distributors. Vyas, G. P.D. (2006). Community Forestry. Agrobios, India.
9. Sim, H. and Hilmi A. (1987), Forestry Extension Methods, FAO Forestry Paper-80, P. 153.

Climate Change Mitigation 3 (2+1)

Objective

To understand the scenario of climate change and international treaties on climate change, for climate change mitigation and conservation of ecosystems

Theory

Global climate change - factors involved greenhouse gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change. Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP, LULUCF, REDD++ and CDM. National action plan for climate change - Green India mission-Indian Network for Climate Change Assessment (INCCA) - State Action Plan on Climate Change. Silviculture and sustainability- criteria and indicators for sustainable plantation forestry in India.

CIFOR guidelines. Analog forestry for site productivity and carbon value. Disturbance- natural and anthropogenic, short- and long- term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans. Invasive – major invasive species in forests – area affected and methodology for mapping. Eradication methods- management. Restoration of invasive affected areas – types - methods approaches, strategies and opportunities. Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Expanding forest and tree cover area – TOF sector in India. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests.

Suggested Readings

1. Anderson, P. and Palik, B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
2. Bravo, F., LeMay, V., Jandl, R., and Gadow, von K. (Eds). 2008. Managing Forest Ecosystems: The Challenge of Climate Change. Springer publication. Pp 324.
3. Claussen, Eileen, Cochran, Vicki, Arroyo, Davis, Debra, P. and Pew. 2001. Climate Change: Science, Strategies, and Solutions. Brill Academic Pub. Pp 393.
4. Markham, Adam (Ed.). 2010. Potential Impacts of Climate Change on Tropical Forest Ecosystems. Amazon publishers.
5. Streck, Charlotte, O'Sullivan, Robert, Tarasofsky, Richard, G., Janson-Smith, Toby. 2011. Climate Change and Forests: Emerging Policy and Market Opportunities. Brookings Institution Press.

Ecotourism 3 (2+1)

Objective

To develop knowledge, understanding, and appreciation of environmentally responsible travel to relatively undisturbed natural areas that promotes biodiversity conservation, has low negative visitor impact, and provides for socio-economic benefits to the local stakeholder communities

Theory

Ecotourism – Definition - History of tourism and evolution of ecotourism. Various forms of tourism - Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism. Organised tours and Free Independent Traveller – World Tourism Organization. Concept of ecotourism and flaws in real world. Problems with definition of ecotourism and criticisms. Dimensions of ecotourism and the criteria to qualify for ecotourism. Declaration – Different forms of ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Ecotourism-its potential in developing countries- Poverty and biodiversity, Ecotourism as a rural development strategy in tropical countries Ecotourism as a land use- possibilities of integration – Ecotourism policies at national and local level. Environmental Impacts of ecotourism and its mitigation - Case studies from different parts of the world- Concept of "scale". The checks and controls and institutional mechanisms for controlling the environmental

impacts, Mitigation of pollution. Social Impacts of ecotourism and precautionary principles to avoid ill effects Stories from different parts of the world narrating ecotourism development and its influence on society and their culture – The societal advantages and the negative impacts of ecotourism development – Ways forward to address the negative social impacts Indigenous people and ecotourism. Ecotourism economics and business – Investment of international agencies like World Bank in ecotourism projects Ecotourism economics at macro and micro economic level in developing countries Ecotourism as a green business and role of green consumerism – Business plans- unique selling points for marketing – Potential of internet in marketing ecotourism – Payments for Environmental services and role of ecotourism Multiplier effects, opportunity costs and leakage in ecotourism industry Sharing ecotourism revenues among stakeholders – Training in ecotourism to deliver quality service. Ecotourism as a vehicle for the conservation of common property resources – potentials and pitfalls, Dangers involved in management of common property resources Relations between the government and the private sector. Ecotourism and Protected Areas Changing paradigms in the Protected Area Management Support at international level for ecotourism Integrated Conservation Development Projects (ICDPS) and role of ecotourism Community based ecotourism programs. Planning and management of ecotourism – Ecotourism plans and management of visitors and other resources including human and natural resources – Quality control, codes of conduct etc. Use of GIS and ICT for effectively managing and planning ecotourism – Criteria and indicators for sustainable management and monitoring – Charter for Sustainable Tourism – Sustainability issues in ecotourism management and ecotourism certification. Ecotourism design – Role of socio-economic factors in decision making – Designing ecotourism products using local technologies – Carrying capacity considerations. – Use of GIS in ecotourism. Ecotourism markets and influences of climate change Existing ecotourism markets and ecotourism market segmentation – Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets.

Practical

Preparation of a thematic compendium after extensive and original independent investigation about the chosen Protected Area. Be familiar with Government policy and legislation, the current policies regarding the component land uses of the study site. Stakeholder analysis and social Impacts Assessment. Identify different stakeholders at different levels. Based on this perform a stakeholder analysis and then conduct social surveys to gather the information required for assessing the impacts of current management and to explore the intervention needed in the chosen protected area. Ecological surveys including Environmental Impact Assessment. Assess the ecological impacts of current human use using standard techniques in order to identify the intervention needed in the chosen protected area.

Suggested Readings

1. Bhatt, S. and Liyakhat, S. 2014. Ecotourism Development in India: Communities, Capital and Conservation
2. Lindberg, K., Wood, M. E. and Engeldrum, D. 1998. Ecotourism- A guide for planners and managers (Environment and Development). Foundation Books.
3. Page, S. J. and Dowling, R. K. 2002. Ecotourism. Pearson Education Limited, Essex. The Ecotourism Society, Vermont.
4. Weaver, D. 2002. Ecotourism. Milton, Queensland, Australia: John Wiley and Sons Australia.

Restoration of Degraded Lands 3 (2+1)

Objective

To impart practical understanding about rejuvenation of forest with tree vegetation and to develop skills on tacking different problem soils with suitable vegetation

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/ wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation /reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas explanation, impact on pant growth and Bio-drainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programs on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development program.

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (Eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation program.

Suggested Readings

1. Hegde, N.G. 1987. Handbook of Wasteland Development. BAIF, Pune 102p.
2. ICAR. 1977. Desertification and its Control. ICAR, New Delhi 358p. National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix.
3. Imeson, A. 2012. Desertification, Land Degradation and Sustainability, John Wiley and Sons.
4. Kumar, Anil and Pandey, R. N. 1989.Wastelands Management in India. Ashish Publishing House, New Delhi.
5. Luna, R. K. 1989. Plantation Forestry in India, International book distributors, Dehra Dun. Forestry; Ministry of Agriculture and Irrigation, Govt. of India, New Delhi 457p.

Urban Ecology and Environment 3 (2+1)

Objectives

1. To understand urban ecology, biodiversity conservation and management for sustainable development
2. To evaluate environmental and social impacts to deal with global challenges of climate change in cites

Theory

Concepts of urban ecology: Theories of urban ecology and linkages with sustainable urbanism, Concepts of Eco cities, smart cities, compact cities etc., Challenges and opportunities of urban, rural and peri-urban growth. Green Spaces, bio-diversity conservation and conflicts: Urban greens: challenges and choices for management, Human nature interactions and urban forest management, introduction to functional diversity and traits, Bio-diversity conservation conflicts, Spatial dimensions of urban ecology. Urban Environment: Introduction to urban morphology, Industrial ecology and symbiosis, Management of air quality and noise, Urban solid waste management, Urban water ecological challenges. Impact Analysis and Ecological Footprint Analysis: Environmental Impact Analysis 10 2, Social Impact Analysis and Strategic Environmental Assessment, Urban metabolism and Ecological Footprint Analysis. Ecological risk assessment framework (Definition, Problem formulation, Risk analysis, Risk characterization, Risk management), Climate change, mitigation and adaptation, Climate modifications and managing climate change challenges in cities, Adaptation and mitigation measures to make cities resilient, Ecosystem services and nature-based solution to address urban resilience.

Practical

Vegetation analysis and characterization of green spaces in nearby urban areas. Identifying challenges in soil waste management in nearby urban areas. Urban Risk assessment and mitigation in urban areas.

Suggested Readings

1. Adler, F. R. and Tanner, C. J. 2013. Urban Ecosystems. Cambridge University Press.
2. Cities and Bio-diversity Outlook. 2013. Action and Policy: A Global Assessment of the Links between Urbanization, Biodiversity, and Ecosystem Services, by Secretariat of the Convention on Biological Diversity.
3. Dale, R. 2004. Evaluating Development Program and Project, Second Edition, Sage Publication.
4. Keitaro Ito. 2021. Urban biodiversity and ecological design for sustainable cities. Springer.
5. Mostafavi, M. and Doherty, G. 2010. Ecological urbanism, published by Baden: Harvard University Graduate School of Design.
6. Morrison-Saunders, A. and Arts, J. (Eds) 2004. Assessing Impact: Handbook of EIA and SEA Follow-up, Earthscan James andJames, London.
7. Parris, K. M. 2016. Ecology of urban environments. Chichester, West Sussex; Hoboken, Nj: John Wiley and Sons Ltd.
8. Singhal, S. and Kapur, A. 2002. Industrial Estate Planning and Management in India – an Integrated Approach towards Industrial Ecology. Journal of Environmental Management, Elsevier Science Ltd., 66, 2002.
9. Sivaramakrishnan, K. and Rademacher, A. 2013. Ecologies of Urbanism in India Metropolitan Civility and Sustainability. Hong Kong China: Hong Kong University Press, Baltimore.
10. United Nations Human Settlements Program (UN-HABITAT). 2011. Global report on human settlements - Cities and Climate Change: Policy Directions

11. World Bank. 2009. Strategic Environmental Assessment in East and Southeast Asia, A Progressive and Comparison Country Systems and Cases, Washington D.C.
12. WWF India. 2011. Impact of urbanization on bio-diversity: Case Studies From India

Plant Biochemistry 2 (1+1)

Objective

To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid-base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver-Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO_2 fixation, regulation of photosynthesis. Metabolism of carbohydrates -glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg Jeremy M, Stryer Lubert, Tymoczko John and Gatto Gregory. Biochemistry.
2. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0-7167-8724-5.
3. Buchanan Bob B, Gruissem Wilhelm and Jones Russell L. Biochemistry and Molecular Biology of Plants.

4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox.
5. Plummer David T. An Introduction to Practical Biochemistry.
6. Rao Beedu Sashidhar and Deshpande Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam S and Manickam A (2009) Biochemical Methods, 3rd edn, New Age International.
8. Thayumanavan, B, Krishnaveni, S and Parvathi, K (2004) Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet Donald and Voet Judith. Biochemistry.
10. Wilson K and Walker J M (2000) Principles and techniques of Practical Biochemistry

Research Methodology 2 (1+1)

Objective

To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey-based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

Statistical Packages for Data Analysis 1 (0+1)

Objective

The art of data collection, processing, analysis and interpretation will be developed to the translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in SYSTAT for analysis- Data manipulation – transformation –

ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, SYSTAT file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Jayaraman, K. and Rugmini, P. 1990. Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.
2. Nigam A.K. and Gupta, V. K. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
3. Panse, V. G. and Sukhatme, P.V. 1967. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
4. Petersen Roger G. 1994. Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

SKILL ENHANCEMENT COURSE

Skill Enhancement Course (Indicative SEC Courses I)

- Commercial Seedling Production
- Forest Machine Learning Technology
- Commercial Forestry
- Landscape Management and Restoration
- Wildlife Photography
- Ecotourism
- Para-taxonomy
- Ornithology
- Herpetology
- Design and Development of Wood Products

Skill Enhancement Course (Indicative SEC Courses II)

- Clonal Seedling Production
- Commercial tree seed production
- Forest Based Industrial Training
- Urban Forestry Designing and Planning
- Wood Working and Carpentry
- Wood Seasoning and Preservation Technology

- Zoo Management
- Wild and Commercial Beekeeping
- Mining Afforestation
- Advanced Wood Working
- Lac and Tassar Cultivation

Skill Enhancement Course (Indicative SEC Courses III)

- Timber Conversion
- Value addition of NTFPs
- Briquetting Technology
- Forest Fire Management
- Activated Carbon Technology
- Wood carving through CNC Technology
- Burlapping Technology
- Micro Forest
- Import and Export of forest Products
- e-Timber Market
- Community Forest
- Human Animal Ecosystem Interface
- AR/VR Module Creation in Forestry
- Forest Resource Assessment
- Multifunctional Agroforestry
- Biofuels Technology through forestry

Skill Enhancement Course (Indicative SEC Courses IV)

- Wildlife Forensic Sciences
- Dendroenergy Generation
- Big Data Management
- Artificial Intelligence in Forestry Operation
- Specialty Seedling Production
- Woodlot Establishment and Management
- Tools for Consulting Forester's
- Application of Drone in Forestry
- Forest Certification
- Arboriculture
- Forest Project Designing and Analysis
- Wood Mechanics
- Mulberry and Non-mulberry based Silk Production
- Internet of Things (IoT) in Forestry
- Marketing and Economics of NTFPs
- Carbon financing projects

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement as for the B. Sc. (Forestry) program.

The online courses can be from any field in forestry can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. These can be taken any time during the 3rd and 4th years of the UG program. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (satisfactorily completed) courses in final transcript issued to the student.

List of Suggestive Courses on SWAYAM/MOOC

Course Title	Duration	Credits
Forests and their Management	12 weeks	1
Wildlife Ecology	12 weeks	1
Introduction to Biology: Ecology	4 weeks	1
Introduction to Biology: Ecology, Evolution, and Biodiversity	17 weeks	1
Introduction to Biology: Biodiversity	5 weeks	1
Ecology: Ecosystem Dynamics and Conservation	5 weeks	1
Fire Ecology	8 weeks	1
Ecology and Society	12 weeks	1
Environmental Studies	12 weeks	1
Environmental Studies: A Global Perspective	6 weeks	1
Toolbox for Environmental Management	5 weeks	1
Environmental Protection and Sustainability	8 weeks	1
Ecosystem and Natural Resources	12 weeks	1
NGO'S and Sustainable Development	15 weeks	1
Nanotechnology Applications in respective fields	8 weeks	1
Personality Development and Communication Skills	8 weeks	1
Personality Development	8 weeks	1
Yoga Practices 1	12 weeks	1
Yoga Practices 2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1

COMMUNITY SCIENCE

Course Curricula for Undergraduate Programme in Community Science UG- Certificate (Community Science) UG- Diploma (Community Science) B.Sc. (Hons.) Community Science

INTRODUCTION

Higher education in community science equips students with the knowledge, skills, and mindset necessary to address real-life challenges while instilling a sense of social responsibility. Community Science embraces a multidisciplinary approach by integrating elements from various fields such as science, social science, and technology. It is a comprehensive field that plays a crucial role in fostering human resource development and leadership skills. It empowers individuals to take charge of outreach programs, enhancing national development efforts through grassroots initiatives and sustainable practices. The NEP-2020 layout a well-defined framework at the undergraduate level providing multiple entry and exit options to students in their whole degree program with more emphasis on Skill enhancement courses, so that if the student exits after completing first-year courses, he/she/ze may be given a Certificate and after exits in the second year will get Diploma.

The restructured course curriculum for the Undergraduate programmes in community science (UG-Certificate, UG-Diploma, and B.Sc. Hons) aims at strengthening critical thinking, creativity, communication, and collaboration among the students. Several new initiatives such as categorization of course credits into core, skill and elective, increased practical orientation, skill enhancement, and internship have been added to newly refurbished undergraduate course curricula of the VI Deans' committee to gradually upskill and imbibe the students with required skills and entrepreneurial capabilities to take up new and challenging roles and become market ready. The first year of study emphasizes building the fundamental knowledge base of the core domain along with the initiation of a choice-based skill enhancement course module from a bouquet of multiple interesting skill enhancement modules offering a wide arena of opportunities to the student.

The second year further reinforces and upskills the proficiency already gained in the first year coupled with a higher level of skill modules, besides enhancing knowledge and understanding in the area

of agriculture informatics and business and entrepreneurship. The third-year courses put more emphasis on strengthening core aspects of the discipline with more orientation toward theory and practices. By leveraging diverse perspectives and methodologies, courses in community science address complex challenges and promote holistic approaches to societal well-being. The final year focuses on the holistic development of the undergraduates by again providing a choice of elective to impart specialized skills in the chosen field of specialization out of the five important domains of community Science with a student READY programme.

Through RAWE and Experiential learning, students engage directly with communities, gaining practical insights and understanding their role in fostering positive change. This not only sharpens their capabilities but also cultivates a deep awareness of their societal impact, encouraging them to contribute meaningfully to the well-being of others. Online learning through digital environments like MOOC/SWAYAM courses will further complement and open new avenues to pursue the passion of the student within the whole span of a four-year degree program. On successful completion of the whole four-year course programme, the degree offered will be an Honours degree named B. Sc. (Hons) Community Science.

The present document of the VI Deans' Committee report of Community Science is an outcome of the valuable suggestions and recommendations of VI Deans' Committee members after having multistage in-depth ponderings and deliberations in a series of virtual meetings along with meticulous immersion and collective in-depth inputs of eminent Deans', emeritus professors and senior faculty as members representing all the five departments of Community Science, stakeholders from related industries, Govt. Institutions and also pass out undergraduate students of the V Deans' Community Science course program across the nation. The contribution of each one in giving shape to this valuable document is thankfully acknowledged.

HIGHLIGHTS

- The B.Sc. Hons. (Community Science) program is designed over 4 years, covering 167 credit hours of coursework. Additionally, students engage in 4 credit hours of non-gradial courses and 10 credit hours of MOOCs/online courses.
- After the admission of students in the university, the students will register for the *Deeksharambh* (Foundation Course of 2 weeks) in the first semester of the degree program. It will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, University academic and research managers and classes on instilling social awareness, ethics and values, cultural heritage, folk art and craft, Indian Constitution, etc. Steps will be taken to identify the strength and weakness of students, diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- Student will have to do common courses under categories like multi-disciplinary, Value added, Ability enhancement courses, NSS/NCC etc.
- The first two years of the course program is dedicated for skill development in Community Science discipline through skill enhancement courses along with basic and fundamental courses. The skill enhancement courses (SEC) of 12 credit hours will be offered during the first and second year of the degree program with full flexibility to the student as per NEP guidelines.

- There are two different SEC modules of 4 credits hours, each to be offered one in each semester in a sequential manner, like SEC module-1 in first semester, SEC module-2 module in second semester. In second year, other two SEC modules of 2 credit hours each will be offered in third semester (SEC module-3) and fourth semester (SEC module-4).
- The students will have flexibility and choice in selection of skill development area from a bouquet of SEC modules to be offered by the parent institute. Each of the SEC module offers five skill development areas of related domains of community science for the students. After one-week common orientation on different skill enhancement modules, students will take up one module as per the interest / local needs and gain complete hands-on experience on the selected module. In addition, University /HEIs may also offer courses in any other areas as identified by it, based on institutional expertise / capabilities/ resources.
- In first year, after satisfactory completion of courses in first two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Community Science on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the practical exposure as well as some part of the fundamental courses related to community science with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of community science. After satisfactory completion of courses in 3rd and 4th semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Community Science on exit.
- The students continuing the study further, would not have to attend the internship after 2nd year. These students will acquire distinct knowledge, skills, competency and confidence to start his/her/ze own enterprise andcan also get good jobs as per their merits.
- The community science courses in the third-year have been designed to impart hard core knowledge of the subject to the students. There will not be an exit after 3rd year. During the 5th semester, the students will have a study tour/ industry visit of 10-12 days' duration, which will be counted as 2 credits (Non-gradial).
- The fourth-year course program has been meticulously designed not only to impart specialized knowledge to the students in the selected major discipline but also to prepare the students to take up employment or entrepreneurship as their future career.
- Students opting for the degree leading to B. Sc. (Hons.) Community Science will study Electives as major/minor/minors of 20 credits in the 7th semester. There will be adequate choice of electives/ specialization courses for the students to opt for. In 8th semester, Student READY program (Experiential Learning, Hands-on Training, Rural Awareness Work Experience (RAWE), In Plant Training/ Industrial attachment/Internship and Student Project) of 20 credits will be offered. The student will have to take three components of Student READY, out of which 10-12 credits of RAWE and 2-4 credits of Internship is mandatory.
- After satisfactory completion of fourth-year course requirements, the student will become eligible for the award of a Degree in B. Sc. (Hons.) Community Science.
- The Universities will have the flexibility to include more courses as Electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.

- The students will also have the choice to take 10 credits of courses either from MOOC/Swayam/ NPTEL/ mooKIT/ edX/ Coursera or any other portal accepted by the University during the third and fourth year as a partial requirement for the degree of B.Sc. (Hons.) Community Science. The MOOCS courses may relate to the main discipline or from any other discipline like social science, psychology, anthropology, economics, language/humanity, music, etc. The objective is to allow the students to groom their passion and strengthen their knowledge and competency based on his/her choices.
- These courses will be non-gradial and a separate certificate would be issued by the Institute/ University offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the successfully completed courses in final transcript issued to the student. These will be added in Academic Bank of Credits of the student.
- The students will register for a maximum of two modules of Skill Development Course/Skill for Employment and Entrepreneurship Development (SEC) during each semester in the first year. Thus, the name(s) of modules taken by the student will be reflected in the UG certificate award, such as UG-Certificate (Community Science) in XXX (names of the modules).

Entry and Exit Options

The entry and exit options for the UG programmes in Community Science are shown in the Fig.1.

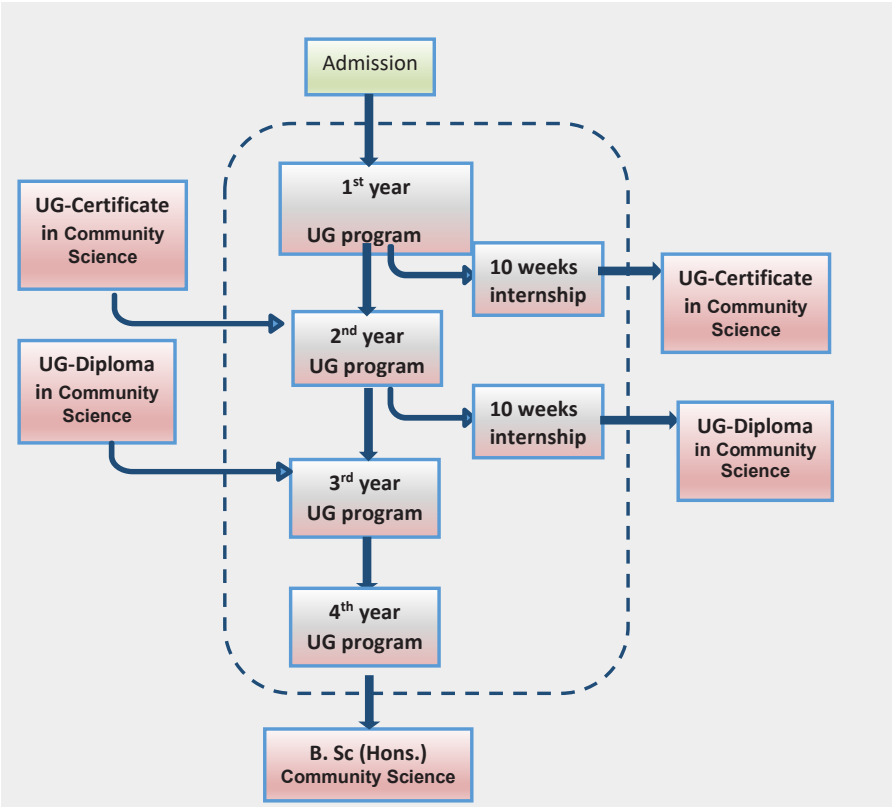

Fig.1. Entry and Exit options for the UG program in Community Science

Exit options

1. UG-Certificate in Community science (Exit after first year and completion of 10 weeks' internship)
2. UG-Diploma in Community Science (Exit after second year and completion of 10 weeks' internship)
3. B.Sc. (Hons.) Community Science (On successful completion of four-year degree requirements)

Admission Eligibility: +2 Science with Biology or Mathematics as one subject/Agriculture from a recognized Board/University or as per the criteria decided by the ICAR/ SAU.

ACADEMIC PROGRAMME

4 Years B.Sc. (Hons.) Community Science

Semester wise course distribution

First year			
I Semester			
S. No.	**Course Title**	**Credit Hours**	**Total credits**
1.	*Deeksharambh* (Foundation Course of 2 weeks)	2 (0+2) Non-gradial	
2.	Food Standard and Quality Control	2 (1+1)	**22 (10+12) (+ 2 NG)**
3.	Textile Science and Fabric Care	3 (2+1)	
4.	Fundamentals of Art and Design	2 (1+1)	
5.	Childhood Development	3 (2+1)	
6.	Communication for Development	2 (1+1)	
7.	Skill Enhancement Course (SEC-I)*	2 (0+2)	
8.	Skill Enhancement Course (SEC-II)*	2 (0+2)	
9.	Farming System Based Livelihood	3 (2+1)	
10.	Communication Skills	2 (1+1)	
11.	National Cadet Corps-I (NCC-I)/ National Service Scheme-I (NSS-I)	1 (0+1)	

*SEC-I and SEC-II to be selected from the list of the basket available under SEC-I module

Semester II

S. No.	Course Title	Credit Hours	Total credits
1.	Food Science and Processing	3 (1+2)	
2.	Fundamentals of Clothing Construction	3 (1+2)	
3.	Fundamentals of Ergonomics	2 (1+1)	
4.	Theoretical Approaches to Parenting	2 (2+0)	
5.	Personality Development	2 (1+1)	
6.	Entrepreneurship Development and Business Management	3 (2+1)	
7.	Environmental Studies	3 (2+1)	
8.	Skill Enhancement Course* (SEC-III)	2 (0+2)	
9.	Skill Enhancement Course* (SEC-IV)	2 (0+2)	
10.	NCC-II/ NSS-II	1 (0+1)	

*SEC-III and SEC-IV to be selected from the list of the basket available under SEC-II module

Post- II Semester Internship (Only for exit option for award of UG-Certificate)

S. No.	Course Title	Credit Hours
1.	Internship (10 weeks)	**10 (0+10)***

*Compulsory Internship for students exercising exit option (UG-Diploma) after Ist Year

Second Year			
Semester III			
S. No.	**Course Title**	**Credit Hours**	**Total credits**
1	Food Packaging and labelling	2 (1+1)	**20 (10+10)**
2	Pattern Making and Draping	3 (1+2)	
3	Computer-aided Interior designing-I	3 (1+2)	
4	Early childhood Education	3 (2+1)	
5	Extension and Rural Development	3 (2+1)	
6	Rural Sociology	2 (2+0)	
7	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
8	Skill Enhancement Course (SEC-V)*	1 (0+1)	
9	Skill Enhancement Course (SEC-VI)*	1 (0+1)	

*SEC-V and SEC-VI to be selected from the list of the basket available under SEC-III module

Semester IV

S. No.	Course Title	Credit Hours	Total credits
1.	Institutional Food Service Management	3 (2+1)	**20 (10+10)**
2.	Retailing and Merchandising	2 (1+1)	
3.	Housing and Space Management	3 (1+2)	
4.	Theories and Practices in Early Childhood Education	2 (2+0)	
5.	Training and Professional Development	2 (0+2)	
6.	Agriculture Marketing and Trade	3 (2+1)	
7.	Agriculture Informatics and Artificial Intelligence	3 (2+1)	
8.	Skill Enhancement Course (SEC-VII)*	1 (0+1)	
9.	Skill Enhancement Course (SEC-VIII)*	1 (0+1)	

*SEC-VII and SEC-VIII to be selected from the list of the basket available under SEC-IV module

Post- IV Semester Internship (Only for exit option for award of UG- Diploma)

S. No.	Course Title	Credit Hours
1.	Internship (10 weeks)	**10 (0+10)***

*Compulsory Internship for students exercising exit option (UG-Diploma) after II Year

Third Year			
Semester V			
S. No.	**Course Title**	**Credit Hours**	**Total credits**
1.	Human Physiology	3 (2+1)	**21 (11+10)**
2.	Food Hygiene and Sanitation	1 (1+0)	
3.	Techniques of Fabric Construction	3 (1+2)	
4.	Principles of Textile Designing	3 (0+3)	
5.	Consumer Education	3 (1+2)	
6.	Adolescent Development	3 (2+1)	
7.	Adulthood Development	2 (1+1)	
8.	Project Management	3 (2+1)	
	Educational Tour (10-12 days)	2 (0+2) Non-gradial	

Semester VI

S. No.	Course Title	Credit Hours	Total credits
1.	Nutritional Biochemistry	3 (2+1)	**21 (13+8)**
2.	Human Nutrition	3 (2+1)	
3.	Traditional Textiles and Costumes of India	3 (2+1)	
4.	Principles of Management	2 (2+0)	
5.	Computer aided Interior designing-II	3 (0+3)	
6.	Marriage and Family Dynamics	3 (2+1)	
7.	Diffusion and Adoption of Innovation	3 (2+1)	
8.	Seminar	1 (0+1)	

	Fourth Year	
	Semester VII	
S. No.	**Course Title**	**Credit Hours**
1.	Research Methodology	3 (2+1)
2.	Statistical methods	2 (1+1)
3	Elective courses from major/ minor (Anyone specialization)	15
	Total	**20**

Semester VIII

S. No.	Course Title	Credit Hours
1.	Student READY- RAWE/ (Internship /In plant / Industrial Attachment) / Experiential learning /Hands on Training/ Student Project	**20**
	On-line courses (MOOC)	10
	Grand Total	**167 + 10* (MOOC) + 4 (NG)**

*On- line courses (MOOC);NG- Non-gradial

List of Elective courses*

Course Number	Course	Credit Hours
Elective-1 Food and Nutrition		
1.	Food Analysis	3 (1+2)
2.	Normal and Therapeutic Nutrition	3 (2+1)
3.	Food Product Development and Formulations	2 (1+1)
4.	Clinical Nutrition	2 (2+0)
5.	Diet and Nutrition Counselling	1 (0+1)
6.	Sports Nutrition	2 (2+0)
7.	Community Nutrition and Education	2 (1+1)
8.	Research Methodology	3 (2+1)
9.	Statistical Methods	2 (1+1)
Elective-2 Apparel and Textile Science		
1.	Advance Draping Technique	3 (0+3)
2.	CAD- Pattern Making and Grading	2 (0+2)
3.	Quality Analysis in Textiles and Apparels	3 (2+1)
4.	Apparel Production Management	3 (3+0)
5.	Agro Textiles	2 (1+1)
6.	Recent Advances in Textiles	2 (2+0)
7.	Research Methodology	3 (2+1)
8.	Statistical Methods	2 (1+1)
Elective-3 Resource Management and Consumer Science		
1.	Residential and Commercial Space Design	3 (1+2)
2.	Colour and Lighting in Interiors	3 (2+1)
3.	Tourism and Hospitality Management	3 (1+2)
4.	Financial Management and Consumer Behaviour	3 (2+1)
5.	Work Space and Product Design	3 (1+2)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)

Elective-4 **Human Development and Family Studies**		
1.	Developmental Challenges in Children	3 (2+1)
2.	Methods and Materials for Teaching Young Children	3 (1+2)
3.	Computer application in ECCE	3 (1+2)
4.	Guidance and Counselling	3 (2+1)
5.	Parent Education and Community welfare Programs	3 (2+1)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)
Elective-5 **Extension Education and Communication Management**		
1.	Extension Program Management	3 (1+2)
2.	Extension Training Management	3 (1+2)
3.	Advertising and Social Marketing	3 (1+2)
4.	Public relations and Communication Management	3 (1+2)
5.	Web designing	3 (0+3)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)
	TOTAL	**20**

*The institutions may formulate additional elective courses as per specific local needs and facilities/expertise available.

Department/ sectionwise course breakup

S. No.		Course Title	Credits	Total Credits
Foundation courses				
1.		Deeksharambh (Foundation Course of 2 weeks)	0+2 (NG)*	4 (0+4) *Credits not included in the total calculated here
2.		Study Tour (10-12 days)	0+2 (NG)* Non-gradial	
Common Courses				
1.	Multidisciplinary courses (MDC) 9 credits	Farming based livelihood systems	3 (2+1)	23 (13 + 10)
2.		Entrepreneurship Development and Business Management	3 (2+1)	
3.		Agriculture Marketing and Trade	3 (2+1)	
4.	Value Added courses + (VAC) 6 credits	Environmental Studies	3 (2+1)	
5.		Agriculture Informatics	3 (2+1)	
6.	Ability Enhancement Courses (AEC) 8 credits	NSS/ NCC – I	2 (0+2)	
7.		Communication Skills	2 (1+1)	
8.		Personality Development	2 (1+1)	
9.		Physical Education, First Aid and Yoga	2 (0+2)	

S. No.		Course Title	Credits	Total Credits
Department of Food and Nutrition				
1.	Core courses	Food Standards and Quality Control	2 (1+1)	32 (15+17)
2.		Food Science and Processing	3 (2+1)	
3.		Food Packaging and labelling	2 (1+1)	
4.		Institutional Food Service Management	3 (2+1)	
5.		Human Physiology	3 (2+1)	
6.		Human Nutrition	3 (2+1)	
7.		Nutritional Biochemistry	3 (2+1)	
8.		Food Hygiene and Sanitation	1 (1+0)	
9.	Skill Enhancement Courses (under SEC Modules-12 credits)	Breads and Buns	2 (0+2)	
10.		Biscuits and Cookies	2 (0+2)	
11.		Cakes and Pastries	2 (0+2)	
12.		Chocolate Making	2 (0+2)	
13.		Quantity Cookery	1 (0+1)	
14.		Traditional Indian Foods	1 (0+1)	
15.		Food Preservation and Storage-I	1 (0+1)	
16.		Food Preservation and Storage-II	1 (0+1)	
Department of Apparel and Textile Science				
1.	Core courses	Textile Science and Fabric Care	3 (2+1)	32 (8+24)
2.		Fundamentals of Clothing Construction	3 (1+2)	
3.		Pattern Making and Draping	3 (1+2)	
4.		Retailing and Merchandising	2 (1+1)	
5.		Principles of Textile Designing	3 (0+3)	
6.		Techniques of Fabric Construction	3 (1+2)	
7.		Traditional Textiles and Costumes of India	3 (2+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Textile Dyeing and Printing	2 (0+2)	
9.		Fabric Embellishment	2 (0+2)	
10.		Indian Embroideries	2 (0+2)	
11.		Quilting and Patchwork	2 (0+2)	
12.		Garment Designing	1 (0+1)	
13.		Accessory Designing	1 (0+1)	
14.		Fashion Illustration	1 (0+1)	
15.		Portfolio Development	1 (0+1)	

S. No.		Course Title	Credits	Total Credits
Department of Resource management and Consumer Science				
1.	Core courses	Fundamentals of Art and Design	2 (1+1)	30 (7+23)
2.		Fundamentals of Ergonomics	2 (1+1)	
3.		Computer aided Interior designing- I	3 (1+2)	
4.		Housing and Space Management	3 (1+2)	
5.		Consumer Education	3 (1+2)	
6.		Principles of Management	2 (2+0)	
7.		Computer Aided Interior Designing- II	3 (0+3)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Housekeeping and Service Management- I	2 (0+2)	
9.		Floral Art and Design- I	2 (0+2)	
10.		Housekeeping and Service Management -II	2 (0+2)	
11.		Event Planning and Management	2 (0+2)	
12.		Interior designing and decoration I	1 (0+1)	
13.		Floral Art and Design- II	1 (0+1)	
14.		Interior Accessories and Furnishings	1 (0+1)	
15.		Interior designing and decoration- II	1 (0+1)	
Department of Human Development and Family Studies				
1.	Core courses	Childhood Development	3 (2+1)	30 (13+17)
2.		Theoretical Approaches to Parenting	2 (2+0)	
3.		Early Childhood Education	3 (2+1)	
4.		Theories and Practices in Early Childhood Education	2 (2+0)	
5.		Adolescent Development	3 (2+1)	
6.		Adulthood Development	2 (1+1)	
7.		Marriage and Family Dynamics	3 (2+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)	
9.		Developmental Assessment II (childhood)	2 (0+2)	
10.		Infant Stimulation Practices	2 (0+2)	
11.		Health Practices in Early Childhood	2 (0+2)	
12.		Establishment of ECCE Centers	1 (0+1)	
13.		Program Planning and Execution in ECCE Centres	1 (0+1)	
14.		Management of ECCE Centers	1 (0+1)	
15.		Monitoring and Evaluation of ECCE Centers	1 (0+1)	

S. No.		Course Title	Credits	Total Credits
Department of Extension Education and Communication Management				
1.	Core courses	Communication for Development	2 (1+1)	28 (9+19)
2.		Extension and Rural Development	3 (2+1)	
3.		Rural Sociology	2 (2+0)	
4.		Project Management	3 (2+1)	
5.		Diffusion and Adoption of Innovations	3 (2+1)	
6.		Training and professional Development	2 (0+2)	
7.		Seminar	1 (0+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Audio Visual Aids for Communication	2 (0+2)	
9.		Extension Teaching Methods	2 (0+2)	
10.		Computerized Instructional Aids Production	2 (0+2)	
11.		ICT and New Media	2 (0+2)	
12.		Print Journalism	1 (0+1)	
13.		Electronic Journalism	1 (0+1)	
14.		Audio and Video Recording	1 (0+1)	
15.		Instructional Video Production	1 (0+1)	
ELECTIVE COURSES				
1.	Food and Nutrition	Food Analysis Normal and Therapeutic Nutrition	3 (1+2) 3 (2+1)	15 (Anyone elective to be chosen)
2.		Food Product Development and Formulations	2 (1+1)	
3.		Clinical Nutrition	2 (2+0)	
4.		Diet and Nutrition Counselling	1 (0+1)	
5.		Sports Nutrition	2 (2+0)	
6.		Community Nutrition and Education	2 (1+1)	
7.	Apparel and Textile Science	Advance Draping Technique	3 (0+3)	
8.		CAD- Pattern Making and Grading	2 (0+2)	
9.		Quality Analysis in Textiles and Apparels	3 (2+1)	
10.		Apparel Production Management	3 (3+0)	
11.		Agro Textiles	2 (1+1)	
12.		Recent Advances in Textiles	2 (2+0)	
13.	Resource Management and Consumer Science	Residential and Commercial Space Design	3 (1+2)	
14.		Colour and Lighting in Interiors	3 (2+1)	
15.		Tourism and Hospitality Management	3 (1+2)	
16.		Financial Management and Consumer Behaviour	3 (2+1)	
17.		Work Space and Product Design	3 (1+2)	

S. No.		Course Title	Credits	Total Credits
18.	Human development and family Studies	Developmental Challenges in Children	3 (2+1)	
19.		Methods and Materials for Teaching Young Children	3 (1+2)	
20.		Computer application in ECCE	3 (1+2)	
21.		Guidance and Counseling	3 (2+1)	
22.		Parent Education and Community welfare Programs	3 (2+1)	
23.	Extension Education and Communication Management	Extension Program Management	3 (1+2)	
24.		Extension Training Management	3 (1+2)	
25.		Advertising and Social Marketing	3 (1+2)	
26.		Public relations and Communication Management	3 (1+2)	
27.		Web designing	3 (0+3)	

Table 1. Summary of credit hours for different categories of courses (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)		
II	10	3(5)	3(6)	1(3) + 2(7)	4	-	23	-	10(12)	
III	16	----		2(8)	2	-	20			
IV	12	3(9)	3 (10)	----	2	-	20	-	10(13)	**10**
V	21	-	-	-	-	-	21	2(11)		
VI	21	-	-	-	-	-	21	-		
VII	20*	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

Note: The credit hours mentioned in the table includes both theory and practical.

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(2) Farming based Livelihood systems
(3) NCC/NSS/NSO
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid and Yoga Practices
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics
(11) Study tour (10-14 days).
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major and minor/s)	:	112
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	**167+10****

Community Science is a multi-disciplinary subject and have perfect amalgamation of many disciplines. Hence, choice of skill based and Elective courses will be offered to student from bouquet of Skill Enhancement Course modules to develop required skill competency in both first year and second year for UG Certificate in Community Science or Diploma in Community Science at the first exit or second exit, respectively. The online learning through digital environment like MOOC/ SWAYAM, courses will further complement and open new avenues to pursue the passion of the student within the whole span of four years of the degree program.

DETAILED SYLLABI

Semester I

Deeksharambh (Induction-cum-Foundation Programme) 0+2 (NG)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.
6. The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:
    i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
    ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
    iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
    iv. Activities to enhance cultural Integration of students from different backgrounds.
    v. Field visits to related fields/ establishments
    vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Food Standards and Quality Control 2 (1+1)

Objectives

1. To understand the adverse effects of chemical substances in food on human beings and about food laws and regulations to prevent adulteration in food
2. To acquire knowledge about the quality and safety aspects of food
3. To induce sufficient knowledge regarding national and international food safety standards and regulations

Theory

Food Quality - Meaning and definition of food quality; quality factors in raw and cooked foods, indicators of food quality. Meaning, importance and ways of Food Quality Assessment; Total quality management; HACCP; Good Hygienic Practices; Good Manufacturing Practices - Risk Analysis, Risk Management, Risk Assessment, Risk Communication - Traceability and authentication, Water quality – Methods of assessment, purification.

Sensory evaluation Physiological bases, sensory characteristics of foods, types, selection and training of sensory panel, requirements for sensory evaluation tests, types of tests, analysis and interpretation of sensory evaluation tests; Methods of Sensory Evaluation and Evaluation cards- Ranking and Rating procedures. Different methods of Quantitative descriptive analysis. Determination of Sensory thresholds and taste Interactions. Objective methods for quality evaluation-Introduction and application. Consumer Studies – Types of Consumer studies- Preference Studies Objectives of Consumer Preference Studies-factors affecting consumer acceptance.

Food laws and regulations at National level and International level- Food Safety and Standards Rules, 2011, FSSAI, AGMARK, BIS, food export and import regulations in India, Codex Alimentarius, Eco friendly products, ISO and others. Food Adulteration Meaning, detection of common adulterants. Food packaging material – Potential contaminants from food packaging material; Food toxins and contaminants- Occurrence, types, their harmful effects, detection in foods, Toxicological effects, limits and methods of removal. Food hygiene and sanitation.

Practical

Detection of common adulterants in foods, Sensory evaluation of some finished products, Quality evaluation of some products using objective methods, visit to quality control laboratory/ food processing industries, FCI, AGMARK, Food Toxicology lab and notes the procedures and parameters used for quality assessment, Market Survey, collection of food labels and preparation of Scrap Book.

Suggested Readings

1. Impact of WTO and Codex.
2. McWilliams, M. (2000) Foods Experimental Perspectives, 4th edn, Prentice-Hall, Inc New Jersey.
3. https://www.fssai.gov.in/https://agriexchange.apeda.gov.in/IR_Standards/Import_Regulation/FoodandAgriculturalImportRegulationsandStandardsReportNewDelhiIndia3 52019.pdf

Textile Science and Fabric Care 3 (2+1)

Objectives

1. To impart knowledge about the basics of textiles and their care

2. To develop a basic understanding of different textile fibres, yarn and fabrics
3. To gain knowledge of the processing of natural fibres and manufacturing of man-made fibres
4. To inculcate an understanding of fibre morphology and physical and chemical properties of fibres
5. To learn about the laundry practices of clothes made of natural and man-made fibres and their care and storage

Theory

Textile: terminology, forms of textile, importance of textile industry in national economy. Classification of textile fibres, Properties of textile fibres; primary and secondary properties. Molecular structure of textile fibres: Monomers, polymers and their types, polymerization and its type degree of polymerization and orientation. Cotton: Fibre processing, fibre varieties and their grading, fibre morphology, physical, chemical, biological properties and end-uses. Bast fibres: Flax, jute, hemp; Fibre processing, fibre morphology, physical, chemical and biological properties and end-use., Wool and specialty hair fibres: classification, processing, wool labelling, fibre morphology, physical, chemical, biological properties and end-uses. Silk: Fibre processing, classification, fibre morphology, physical, chemical, biological properties and end-uses. Chemical spinning: Wet, melt and dry. Common properties of man-made fibres. Regenerated cellulosic fibres: Viscose, Cuprammonium and High Wet Modulus rayons; fibre manufacturing, microscopic structure, physical, chemical, biological properties and end-uses. Modified cellulosic fibres: Diacetate and triacetate; fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses. Synthetic fibres: Nylon, polyester, acrylic and elastomeric; fibre manufacturing, fibre microscopic structure, physical, chemical, biological properties and end-uses. Mechanical spinning: Ring spinning method, classification of yarn on the basis of structure (simple yarns and different type of novelty yarns), twist direction, twist amount, fibre length and end-uses. Methods of fabric construction: Weaving, knitting, braiding, tufting, net, lace making, crocheting, macramé, stitch through fabrics, quilted fabrics, laminated fabrics, bonded fabrics, felt, nonwoven and films. Laundry: Definition, principles, equipment, laundry methods and dry cleaning. Stain removal: Classification of stains and methods of removing different stains. Laundry agents: Water, soap, and other laundry auxiliaries - stiffening agents, bleaches and blue. Care of textiles: Labelling Act, importance of labelling, labels and tags used in textiles. Storage of clothes: Requirements of short term and long-term storage, folding and packaging of clothes.

Practical

Fibre identification: Visual test, Burning test, Solubility and Microscopic view. Collection and identification of different types of yarns. Collection and identification of fabric samples of different construction. Washing of garments made up of cotton, wool, silk and manmade fibres. Dry cleaning. Removal of different stains from fabric surface. Visit to textile industry.

Suggested Readings

1. Cowan, M. L. and Jungerman, M. E. 1969. Introduction to textiles. 6th edn. New York. Appleton Century – Crofts.325 p.
2. Dantyagi, S. 1959. Fundamentals of textiles and their Care. New Delhi. Orient Longman Limited.

3. Deulkar, D. and Tarabai.1967. Household textiles and laundry work. 3rd edn. Delhi. Atma Ram and Sons Ltd.
4. Hall, A.J. 1969. A Students' Textbook of Textile Science. London. Allman and Son Ltd
5. Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
6. Joseph, M. L. 1986. Introductory textile science. 5th edn. New York. CBS College Publishing.
7. Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd
8. Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
9. Rastogi Deepali and Chopra Sheetal. 2017. Book on Textile Science. Orient Blackswan Private Limited. Pages 352.
10. Ryszard Kozlowski, Maria Mackiewicz-Talarczyk. 2020. eBook on natural Fibres: Processing and applications (Vol II). Woodhead Publishing. ISBN:9780128190708. Pages 752.
11. Stout, E.E. 1970. Introduction to textiles. 3rd edn. New York. John Wiley and Sons, Inc.
12. Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
13. Vatsala, R. 2003. Textbook of Textiles and Clothing. New Delhi. Indian Council of Agricultural Research.
14. Vilensky, L. D. and Gohl, E. P.G. 1999.Textile Science. Delhi. CBS Publishers and Distributors.
15. Wingate, I. B. 1970. Textile Fabrics and their selection.6th edn. New Jersey. Prentice Hall Inc.
16. Wynne, A. 1997. Textiles. London, Macmillan Education Ltd. 310 p.

Fundamentals of Art and Design — 2 (1+1)

Objectives

1. To make the students aware of the fundamentals of Art and design' and develop skills in designing functional and decorative interiors.
2. To help students gain knowledge of-
   - Element of Art and principles of Design
   - Colour- its importance, characteristics and applications in interior Furniture and furniture arrangement
   - Types of floor and floor finishes
   - Types of windows, Functional and decorative window treatments.
   - Types and placement of Accessories
   - Importance and Types of Home lighting

Theory

Introduction and objectives of interior decoration. Design- Definition, Types, features and requirements. Elements of art and their importance in interior decoration: Line, Form, Colour, Texture, Pattern. Principles of design and their application to enrich the interiors: Harmony, Proportion, Rhythm, Emphasis, Balance. Colour: sources of colour, Colour theories, properties of colour, emotional effect of colour, colour schemes, colour plans for interiors. Furniture: types of furniture, materials and finishes of furniture, factors affecting the selection of furniture, care and maintenance of furniture, furniture arrangement. Walls- Classification, Types of building wall,

Exterior and interior wall finishes. Floor: importance, types of floor and floor covering, Selection, care and maintenance of floor covering. Ceilings: types, materials and functions, Doors, windows and ventilators: Importance and types, Functional and decorative window treatments, Curtain and draperies, top treatments of windows- pelmets, valances, swags and tails. Hardware for curtains, blinds. Factors considered in selection of curtain and draperies. Lighting: importance, types of lighting and its application.

Practical

Learning elements of art and principles of design. Development of motif and design through art principles. Colour- colour schemes, values and intensity scale, colour wheel. Furniture - care and arrangement of furniture. Accessories - preparation and placements of accessories. Window treatment: Preparation of soft window treatment. Study of lighting fixtures. Market survey - different types of wall and floor coverings. Types of flower arrangement, learning different types of table setting, napkin folding.

Suggested Readings

1. Dodsworth S (2019) The Fundamentals of interior design. Bloomsbury Publishing PLC.
2. Faulkner and Faulkner (1975) Inside Today's Home. New York: Holt, Rinehart and Winston.
3. Kasu Ahmed A (2005) An introduction to Art, Craft, Science, Technique and Profession of Interior design. Ashish Book Center.
4. Parimalam P, Andal A and Premalatha M R (2008). A Textbook of interior Decoration. Satish Serial Publishing house.
5. Seetharaman P (2019) Interior design and Decoration. CBS publishers and distributors. New Delhi.

Childhood Development 3 (2+1)

Objectives

1. To make students aware about the fundamental as well as overall development of the child from conception to late childhood
2. To understand human development and its significance
3. To create awareness about the process of human growth and development
4. To identify the genetic and environmental influences on human life
5. To study the inter-relatedness of physical, cognitive, social, emotional and motor development
6. To understand the theories of human development

Theory

Concept of human development, Stages of human development, Domains of human development and its characteristics, Definition of growth and development, Determinants of human growth and development, Principles of human growth and development-Concept of heredity and environment, the role of heredity and environment on development–perspectives on development: Naturalism, environmentalism, maturational, need, ecological, ethological, cognitive, psycho-analytical, social (socio-cultural and social learning), language, behaviour, psycho-social,

intelligence and moral reasoning -Prenatal, peri- natal and postnatal stages- conception, care during pregnancy, labour/ birth, Early Childhood {birth to eight yrs}-Physical, motor, social, emotional, cognitive and language development of infancy, babyhood, preschool and early school yrs- Late childhood (eight to 14 yrs): Physical, motor, social, emotional, cognitive and language development. Guidance to parents for promoting holistic development of children.

Practical

Observational visits to well-baby clinics to observe full term and preterm babies and observe/ record its characteristics. Visit to Early Childhood Centers, study physical, motor, social, emotional, intellectual, language, moral and personality development at different stages and prepare interpretive reports. Collect and evaluate reports/ article / news / other secondary data related to recent issues, trends and challenges of Human development and write an analytical report. Case study of individuals in different stages of development - Infancy, early childhood, and late child hood Critical analysis of case study reports. Preparation of Resource file.

Suggested Readings

1. Bronfenbrenner, V. 1979. The ecology of human development. Cambridge, Harvard Univ. Press.
2. Berk, E. L. 2013. Exploring life span development.3rded. McGraw Hill, New York.
3. David, M.T., Garavan, L. and Dooley, M. 2012.Fundamentals of human resource development. *SAGE Publications Ltd*
4. Hall, Calvin S and Lindzey. G. 1978. Theories of personality. John Wiley and Sons
5. Harris, J.R. and Liebert, R.M. 1987. The child. Prentice Hall, Inc.
6. Munsinger, H. 1971. Fundamentals of child development. Holt, Reinhart and Winston, Inc.
7. Papalia, D.E. and Olds, SW. 2008. Human development. 11th edn. McGraw Hill. New York.

Communication for Development 2 (1+1)

Objectives

1. To develop competence in effective communication
2. To develop understanding of various concepts of communication process
3. To develop competence in oral and written communication

Theory

Communication process – concept, elements, and their characteristics. Principles of Communication. Basic functions of communication. Models of Communication. Barriers of communication. Concepts related to communication; fidelity of communication, empathy credibility, feedback in communication, communication gap and distortion. Forms and types of communication– Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication, Digital communication.

Practical

Practice sessions on written communication- Writing official letters, Notices/Circulars, Preparing minutes of meetings; Practice sessions on Oral communication- Planning and delivering an effective talk; Planning for digital communication- Arranging educational programs using digital

media.

Suggested Readings

1. Dasgupta, S. 1989. Diffusion Agricultural Innovations in Village India. Wiley Eastern Ltd, New Delhi.
2. Jalihal, K. A. and Veerabhadraiah, V. 2007. Fundamentals of Extension Education and Management in Extension. Concept Publ. Co.
3. Ray, G.L. 2005. Extension Communication and Management. Kalyani Publ.
4. Reddy, A.A. 1987. Extension Education. Shree Lakshmi Press, Bapatla. Guntur, AP.
5. Somani, L.L. 2012. Extension Methodologies for Transfer of Agricultural Technology. Image Print Media, Udaipur
6. Supe, S.V. 2009. Textbook of Extension Education. Agrotech Publishing Academy Udaipur.

Farming-based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry, duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming based livelihood systems, Schemes and programmes by Central and State Government, Public and Private organizations involved in promotion of farming based livelihood opportunities. Role of farming based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based

enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar].
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA.
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar.
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment. Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2(1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Allport G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

National Cadet Corps (NCC-I) 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline; Drill- aim, general words of command, attention, stands at ease, stand easy and turning; Sizing, numbering,

forming in three ranks, open and close order march, and dressing; Saluting at the halt, getting on parade, dismissing, and falling out; Marching, length of pace, and time of marching in quick/ slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march; Marking time, forward march, and halt. Changing step, formation of squad and squad drill; Command and control, organization, badges of rank, honors, and awards; Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects; Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning; Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) **1 (0+1)**

Objectives

1. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work,
2. To be skillful in executing democratic leadership, developing skill in programme,
3. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness programmes

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS;

Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health;

NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change;

Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration;

Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism;

Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family

and society. Concept of family, community (PRIs and other community-based organizations) and society.

Skill Enhancement Courses (SEC-I module) 4 (0+4)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-certificate, they can work with bakery/confectionary shops/ units, textile dyeing units/ embroidery shops/housekeeping job services, event planning units, development counselling service providers, AV Aids making units/shops, etc. or can go for self-employment.

Indicative modules for SEC- I *(any one module to be selected)*

Module	Course	Credit Hours
Bakery and Confectionary Management- I	Breads and Buns	2 (0+2)
	Biscuits and Cookies	2 (0+2)
Textile Design and Embellishment- I	Textile Dyeing and Printing	2 (0+2)
	Fabric Embellishment	2 (0+2)
Event Management and Housekeeping- I	Housekeeping and Service Management-I	2 (0+2)
	Floral Art and Design-I	2 (0+2)
Childhood Development and Assessment- I	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)
	Developmental Assessment II (Childhood)	2 (0+2)
Extension Education for Community Development- I	Audio Visual Aids for Communication	2 (0+2)
	Extension Teaching Methods	2 (0+2)

In addition to the above modules, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the above modules.

Module on Bakery and Confectionary Management-I

Breads and Buns 2 (0+2)

Objectives

1. To enable students to learn the basics of producing breads and buns
2. To acquaint the students with newer technologies and machineries used in product development
3. To develop skills of students in making of breads and buns at professional level
4. To impart knowledge about commercialization of breads and buns
5. To build confidence among students to start a new career in bakery

Practical

Role of ingredients in breads and buns. Characteristic features of ingredients of bread and buns. Quality assessment of raw ingredients used in bread and buns. Breads and buns– role of ingredients – various types of breads and buns– basic procedure in production. Type of bread and bun- multigrain bread, pita bread, rye bread, sour dough, whole wheat bread, bread stick, banana

bread. Bread and bun packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of bread and buns. Storage of breads and buns– slightly cool, dry, dark place. Visit to breads and buns industry. Project planning for financial assistance for a small-scale industry on breads and buns making and writing report.

Suggested Readings

1. Arora A.K. 2007. Food Service and Catering Management. APH Publishing Corporation, New Delhi.
2. Chakrabarty MM. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
3. Dendy DAV and Dobraszczyk BJ. 2001. Cereal and Cereal Products. Aspen.
4. Parvinder S. Bali. 2018. Theory of Bakery. Oxford publishing

Biscuits and Cookies 2 (0+2)

Objectives

1. To enable students to learn the basics of producing biscuit and cookies
2. To acquaint the students with newer technologies and machineries used in product development
3. To impart knowledge about commercialization of biscuit and cookies
4. To build confidence among students to start a new career in bakery.

Practical

Biscuits and cookies – role of ingredients – various types of biscuits and – basic procedure in production. Role of ingredients in biscuits and cookies, Characteristic features of ingredients of cookies. Quality assessment of raw ingredients used in cookies. Type of cookies Sheeted type cookies making Bar type cookies making Piped type cookies making, dropped type cookies making, rolled type cookies making. Type of biscuits- digestive biscuit, custard cream, short bread, chocolate biscuit, rolled biscuits drop biscuit. Biscuits and cookies packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of biscuits and cookies. Storage of biscuits and cookies– slightly cool, dry, dark place. Project planning for financial assistance for a small-scale industry on biscuit and cookie making and writing report.

Suggested Readings

1. Arepally, Divyasree. 2020. Biscuit baking: A review. Uncan Manley Woodhead publishing,
2. Arora, A.K. 2007.Food Service and Catering Management. APH Publishing Corporation, New Delhi.
3. Bali, Parvinder S. 2018. Theory of Bakery. Oxford publishing.
4. Chakrabarty, M.M. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
5. Dendy, D.A.V. and Dobraszczyk, B. J. 2001. Cereal and Cereal Products. Aspen.
6. https://en.m.wikipedia.org/wiki/Biscuit
7. Martins, Z. E. 2017.Trends in Food Science and Technology 67, 106-128, 2017.
8. Mathuravalli S.M.D.2021.Handbook of Bakery and Confectionery. CRC Press

Module on Textile Design and Embellishment- I

Textile Dyeing and Printing 2 (0+2)

Objectives

1. To impart skills in dyeing of cotton fabric with different dyes and designing of fabric through tie and dye and batik techniques
2. To develop competence in printing by using block, screen, and stencil
3. To give hands on experience in fabric surface enrichment through dyeing and printing techniques.

Practical

Introduction to dyeing and printing (Classification of dyes and their suitability to different fibres, Different styles of printing: Resist, direct and discharge, Different methods of printing: Stencil, block, screen and heat transfer printing). Preparation of fabric for dyeing and printing: De-sizing, scouring and bleaching of cotton fabric. Dyeing of cotton fabric with direct dyes, reactive dyes and naphthol dyes and preparation of shade card with different dye concentrations. Dyeing of Textiles with natural dyes and application of mordants. Sample designing through different techniques of tie and dye: pleating (diagonal and straight), fold and tie, object tying, ruching, stitching, marbling, tied circles. Sample designing through different techniques of batik with wax resist: Painting, scratching, sprinkling and marbling. Dyeing with naphthol dyes, washing and dewaxing. Preparation of printing paste and printing of cotton fabric using: (Block printing, Screen printing: Preparation of screen and printing on fabric, Stencil printing: Preparation of stencil and negative and positive stencil printing with painting and spraying method). Preparation of one article using any of the above techniques or combination of them.

Suggested Readings

1. Gahlot, M and Rani, A. 2016. A Laboratory Manual on Textile Designing and Basic Finishing. Published by Govind Ballabh Pant University of Agriculture and Technology, Pantnagar.
2. Gopal Krishnan, D. and Karthik, T. 2016. Basics of Textile Chemical Processing. Daya Publishing House, Astral International Pvt. Ltd., New Delhi.
3. Hall, A.J.1955. Handbook of Textile Dyeing and Printing. The National Trade Press.
4. Mahapatra, N. N. 2016. Textile dyes and dyeing. Woodhead Publishing India In Textiles.
5. Matthew, C. 2011. Handbook of Textile and Industrial Dyeing: Volume 1: Principles, Processes and Types of Dyes. Woodhead Publishing Series in Textiles
6. Matthew, C. 2011. Handbook of Textile and Industrial Dyeing: Volume 2: Applications of dyes. Woodhead Publishing Series in Textiles.
7. Prayag R.S. 1988.Technology of Textile Printing. Sri Printers
8. Shenai, V.A. 1985.Technology of Printing, Technology of Textile Processing. Vol.-IV. Sevak Publ.
9. Shenai, V.A.1994.Technology of Dyeing. Sevak Publ.
10. Story J.1974.The Thames and Hudson Manual of Textile Printing. Thames and Hudson.

Fabric Embellishment 2 (0+2)

Objectives

1. To develop awareness among students about fabric embellishment
2. To develop skills in various embellishment techniques

Practical

Fabric embellishment/Fancy Construction Methods: An orientation, Survey of Embellishment material available in the market, Introduction about Embroidery tools, Basic hand embroidery stitches- Stem, chain, lazy dazy, buttonhole, herringbone, satin, bullion, long and short, French knot, feather, fly, spider stitch, Other fancy embroidery stitches, Machine Embroidery -Introduction and sample preparation - Motif embroidery machine and border embroidery machine, Metal Thread Embroidery-Ari, Zardosi, Gota patti, Danka and sample preparation , Bead work ,Mirror work - sample preparation.

Suggested Readings

1. Carr, Harold and Latham, Barbara. 1992. Fashion Design and Product Development, Blackwell Science.
2. Gahlot, M. and Rani, A. 2016. Textile Designing and Basic Finishing. University Press. G.B. Pant University of Agriculture and Technology, Pantnagar.
3. Tyles, D.J. Materials Management in Clothing Production. Blackwell Science.
4. Withers Sara. 2005. Bead-Work. Chartwell Books.

Module on Event Management and Housekeeping- I

Housekeeping and Service Management I 2 (0+2)

Objectives

1. To provide an overview of the key issues of housekeeping and maintenance management
2. To understand the theoretical and practical knowledge that constitutes the work of housekeeping
3. To illustrate the complexities and demands of working in the industry through the scope of housekeeping
4. Provide the student with the competencies to function professionally within the housekeeping department

Practical

Types of lodging establishments, organizational chart – duties and responsibilities of housekeeping employees. - Communication techniques and skill. Handling of clients. - Handling complaints and emergencies – Accommodation operation - of co-ordination between Front Office, Maintenance and Security departments - setting and different types of Bed making - Napkins Folding - Table etiquettes - Cleaning equipment – Selection and care of equipment - Use and care material required by the House Keeping Department - Cleaning methods – Placement of flower arrangements and other decorative items. - Pest control and eradication –Reporting accidents Safety procedures at the workplace - Use protective equipment.

Suggested Readings

1. Casado, M. 2000. Housekeeping Management. New York: John Wiley and Sons, Inc.
2. Kappa, M., Nitschke, A. and Schappert, P. 1995. Housekeeping Management. New York: Educational Institute of the American Hotel and Motel Association.
3. Martin, R. 1998. Professional Management of Housekeeping Operations. (3rd edn). New York: John Wiley and Sons, Inc.
4. Robinson, M. 2004. Housekeeping Picador USA (first published March 1st 1980)

Floral Art and Design - I 2 (0+2)

Objectives

By the end of the course, the student must be able to:

1. Understand how to use fundamental techniques for creating floral designs
2. Develop floral designs according to the occasion - weddings, birthdays, parties, funerals etc., - each having specific flower arrangement patterns
3. Create popular forms of flower art such as flower carpet and stage decoration, flower painting, garlands, bouquets and flower show, drying flowers, Driftwood Craft, Potpourri
4. Get awareness about Ikebana flower arrangements, indoor plants and Bonsai Culture to convey through symbolism on how nature and art relate to daily living
5. Study and analyze floral art creations

Practical

Practice on applying elements and principles of design in floral art - Selection and preparation of plant and other material for floral art - Practicing techniques and tools, Rules, Styles and Colour schemes in flower arrangement and floral craft - Creating theme or idea in floral art - Applying preservation techniques of flowers/ foliage - Developing basic shapes and practicing different styles of flower arrangements - Developing theme boards, designing backgrounds and floral décor suitable to the occasion - Developing designs for Garland, flower bouquet, Potpourri, flower painting and carpets etc. - Preparation of permanent/ dry floral arrangement/ Driftwood Craft - Visit to shows and gardens to acquire basic knowledge about Bonsai techniques and Indoor gardening - Visit to a florist store to understand the basic procedures for selection and care of flower and plant materials- Developing theme boards for stage decoration - Visit to different occasions to evaluate commercial stage decoration ideas - Organizing shows/ exhibitions for sale of flower craft.

Suggested Readings

1. Akinseye, Akeshi and Akisanya, Sade. 2016. The Art of Floral and Event Design. Kesh Luxury Group, Chicago.
2. Benzakein, E., Chai, J and Jorgensen, J. 2020. Floret Farm's - A Year in Flowers: Designing Gorgeous Arrangements for Every Season. Chronicle Books LLC, San Francisco.
3. Caballero Roberto. 2012. Decorating with Flowers: A Stunning Ideas Book for all Occasions. Tuttle Publishing, United States.
4. Dupon Olivier. 2014. Art Flowers: Contemporary Floral Designs and Installations. Potter Style Publishers, Australia.

5. Jan Hall and Sarah Waterkeyn. 1994. The Art of Flower Arranging. Smithmark Publishers.
6. Judith Blacklock. 2016. Buying and Arranging Cut Flowers - The Essential A - Z Guide. Flower Press; Spl. Edition, United Kingdom.
7. Putnam, D. and Putnam, M. 2021. Flower Colour Theory. Phaidon Press Ltd., London, United Kingdom.
8. Rachel Siegfried. 2017. The Flower Book: Let the Beauty of Each Bloom Speak for Itself. Dorling Kindersley Limited, London, United Kingdom.
9. Shinchi Nagatsuka. 2021. Modern Japanese Ikebana: Elegant Flower Arrangements for Your Home (Contains 42 Projects). Tuttle Publishing, United Kingdom.
10. Sonya Patel Ellis. 2022. The Modern Gardener: A practical guide to houseplants, herbs and container gardening. Harper Collins Publishers, New York

Module on Childhood Development and Assessment- I

Developmental Assessment I (Infancy and Toddlerhood) 2 (0+2)

Objectives

1. To learn about the various standard tools and techniques for assessing development of Infants and toddlers
2. To learn to administer the standard tools to assess the development of new born, infants and toddlers
3. To learn about the ethical issues in assessing children on various areas of development
4. To create awareness about challenges in developmental assessment of young children

Practical

Orientation on screening and developmental assessment of children for various developments through different tools and techniques - Exploring existing areas, Purpose of use of tests and techniques and classification. Criteria for selection and use of test – reliability and validity and wide acceptability; Approaches and tools in developmental screening, Trends and challenges in developmental assessment of young children, Advantages and abuses of testing and tests; Orientation on formal and informal measures in assessment, special considerations and ethical issues in assessing various areas of developments of New born, Infants, Toddlers.

Conducting tests and report writing for each test Neonatal assessment – APGAR* and Gestational age, Neonatal Behavioral Assessment Scale (BNBAS), Infant and Toddler hood assessment - Anthropometric measurements* and national and international standards, Developmental Screening Test, Bayley's Scale of Infant. Pramila Pathak's Mental and Motor Growth of Indian babies, Vineland social Maturity scale.

Suggested Readings

1. Anastasi, A. 1997. Psychological testing.7th edn. Pearson publishers
2. Losardo, A. 2011. Alternative approaches to assessing young children. 2nd edn. Brooker publishing.
3. Minds, L. 2014. Assessing young children. 5thed. Pearson publication.

4. Manuals of the respective tests Development (BSID)/latest version*, Pramila Pathak's Mental and Motor Growth of Indian babies, Vineland social Maturity scale *;

Developmental Assessment II (Childhood) **2 (0+2)**

Objectives

1. To learn about the various standard tools and techniques for assessing development of children
2. To learn to administer the standard tools to assess the development of children
3. To learn about the ethical issues in assessing children on various areas of development
4. To create awareness about challenges in developmental assessment of children

Practical

Special considerations and ethical issues in assessing various areas of developments of Pre-schoolers, Pre-Primary school children, Primary School Children Middle School Children and Secondary /Higher Secondary School Children, conducting tests and report writing for each test: Screening and assessment of preschool and Pre-primary school children- Stanford Binet Intelligence Scale*, Wechsler Scale of Intelligence for Preschool and Primary School Children*, Vineland Adaptive Behavior Scale, DAS II, Pea body Picture Vocabulary test or similar test, Ecological assessment of Preschool and Pre-primary school children- HOME Inventory, Screening and assessment of Primary School Children- Parent child relationship Scale- latest test, Wechsler Intelligence Scale of for children, Learning disability tests: Diagnostic test of reading disorder-, Screening and assessment of Middle School Children- Children's self concept scale-, Anxiety scale, Thematic Apperception Test (TAT)*, Children's Apperception Test (CAT)*, General well being scale-, Screening and assessment of Secondary /Higher Secondary School Children - Emotional Intelligence scale- /Emotional Maturity Scale, Case studies, Presentation of reports. Counselling parents on developmental deviations observed

Note: The test marked with * are compulsory. Latest tests with concurrent validity for each area of assessment should be taught.

Suggested Readings

1. Anastasi, A. 1997. Psychological testing.7th edn. Pearson publishers
2. Losardo, A. 2011. Alternative approaches to assessing young children. 2nd edn. Brooker publishing
3. Minds, L. 2014. Assessing young children. 5th edn. Pearson publication.
4. Manuals of the respective tests.

Module on Extension Education for Community Development- I

Audio Visual Aids for Communication **2 (0+2)**

Objectives

1. To equip with practical skills in planning and preparation of various audio-visual aids
2. To provide hands-on experience in the use and presentation of various audio-visual aids

Practical

Planning, designing and preparation of posters. Planning, designing and preparation of bars, flow charts, striptease charts and line charts, Flip and overlay charts. Planning, designing and development of 2D and 3D models. Planning, designing and preparation of flash cards. Collection of samples and specimens. Preparation of various types of puppets and presentation of puppetry, slides and flannel graphs. Planning, recording and presentation of simple audio messages. Organization of exhibition with audio visual aids.

Suggested Readings

1. Chauhan Jitendra (2016): Communication and Extension Management, 2nd edn, Kushal Publications and Distributors.
2. Dahama O P and Bhatnagar O P. (2012): Education and Communication for Development, 2nd edn, Oxford and IBH Publishing Co. Pvt. Ltd.
3. Dubey V K and Bishnoi Indira (2009): Extension Education and Communication, First edition., New Age International Publishers, New Delhi.
4. Grover Indu, Yadav Lali, Kaushik Sushma and Varma Shashi Kanta (2002): Communication and Instructional Technology, Agrotech Publishing Academy, Udaipur.
5. Lal Harmesh, Bhushan Shailendra and Kumar Meenu (2018): Audio-Visual Aids to Educational Technology.
6. Ray G L (2017): Extension Communication and Management, 8th edn, Kalyani Publishers, Ludhiana.
7. Reddy Adivi (2007): Extension Education, 7edn, Sree Lakshmi Press, Guntur.
8. Sandhu AS, and Sandhu Anoop Singh (2019): Textbook on Agricultural Communication (Process and Methods), CBS Publishers and Distributors Pvt. Ltd.

Extension Teaching Methods 2 (0+2)

Objectives

1. To enhance the extension teaching skills for development communication
2. To develop an understanding about the group specific extension teaching methods for dissemination of information
3. To provide hands on experience for application of extension teaching methods

Practical

Orientation to various extension teaching methods; Planning and use of selected extension teaching methods- familiarization with individual methods – farm and home visit, field trip, office calls, personal letters, and telephone calls; Group methods- method demonstration, group meeting, focuses group discussion, role play, drama, puppet show, small group teaching method; Mass media methods – farm publications, circular letters, campaigns, exhibitions, posters, banners, radio, TV, and social networking sites; Selection and use of suitable audio-visual aids for effective extension teaching; E-extension- internet, radio and teleconferencing;, Mobile phone- applications; Computer based instruction- teaching/learning platforms; Preparation and presentation of a lesson plan using conventional methods.

Suggested reading

1. Ray G L (2017): Extension Communication and Management, 8th edn, Kalyani Publishers, Ludhiana.
2. Reddy Adivi (2007): Extension Education, 7th edn, Sree Lakshmi Press, Guntur.
3. Dahama O P and Bhatnagar O P (2012): Education and Communication for Development, 2nd edn, Oxford and IBH Publishing Co. Pvt. Ltd.
4. Dubey V K and Bishnoi Indira (2009): Extension Education and Communication, First edition., New Age International Publishers, New Delhi.

Semester II

Food Science and Processing 3 (1+2)Objectives

1. To develop the skills for understanding structural, compositional and nutritional importance of various foods and their processed products
2. To develop the skills on the properties of food and various food groups and their role in food products

Theory

Food groups, food guide pyramid and MyPlate- importance, Objectives of cooking, processing, preservation, methods of cooking and processing with their merits and demerits. Nutritive value of foods during cooking and processing. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery. Legumes, nuts and oil seeds - Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Techniques of processing of fruits and vegetables. Milk and milk products – Composition, types, products, effect of acid on milk cookery, uses and functions. Milk processing – products. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish- Types, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Processed meat, poultry and fish products. Sugars- Types, composition, manufacturing process, effect of heat and acid, functions in cookery. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats. Brief overview of beverages. Condiments and spices, importance in daily life. Processed spice products.

Practical

Laboratory conduct and responsibilities; knowledge of different food stuffs in English, Hindi and local language. Terms used in cookery, weights and measures; identification and use of different kitchen items and equipment. Identification and listing of various food groups; market survey of processed and preserved foods. Cereal cookery. Cereal processing – extrusion, puffing, flaking, germination and baking. Pulse processing – germination, puffing, convenience mixes. Preparation of cereal and pulse combined products and other regional preparations. Nuts and oilseeds. - Oil extraction, Preparation of chikki, til, ladoos, thandai. Milk cookery-processed milk products. Egg cookery- Quality evaluation of egg, preparation of boiled egg, scrambled egg, poached egg. Meat and fish cookery. Preparation of meat and fish-based products. Fruits and vegetables cookery. Processed fruits and vegetables products - Preparation of sauces, pickles, squash, RTS, jam, jelly and chips.

Curry and salad. Sugar cookery - Stages and products. Crystaline and Non-crystaline candies. Fats and oils. Preparation puris, cakes and biscuits. Appetizers. Visit to food industries.

Suggested Readings

1. Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
2. Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
3. Khadder, V. (1999). Text book of Food, Storage and Preservation. Kalyani Publishers, New Dehi.
4. Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
5. Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
6. Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

Fundamentals of Clothing Construction 3 (1+2)

Objectives

1. To educate students regarding importance and requirement of clothing in human life
2. To provide primary knowledge about different aspects of clothing construction
3. To develop basic stitching skills of the students

Theory

Terminology related to clothing construction. Sewing tools and supplies, their selection and maintenance-tools required for measuring, drafting, cutting and stitching. Different sewing supplies used in clothing construction. Sewing machine: Its parts and their function, operation and maintenance, Solving common machine problems. Types of sewing machines. Different methods of making paper pattern their advantages and disadvantages. Selection of fabric for different clothing used for different purposes. Preparation of fabric for cutting, and layout of paper pattern on different fabrics patterns including plain, print, lines, plaid and check. Implications of clothing in human life, different functions of clothing. Social, physical, economical and psychological factors affecting clothing selection. Clothing for infant, toddler, pre-schooler, school age children, teenager, adult and senior citizen. Elements and principles of design applied to apparel designing.

Practical

Use and maintenance of different sewing tools, equipment and supplies used for clothing construction. Sewing machine – Its operation and care, identifying and solving machine problems. Hand stitches and their types – basting, hemming, back stitch, overcast stitch, blanket stitch, buttonhole stitch, cross stitch, slip stitch etc. Attaching different fasteners- Button and button hole, hook and eyes, snap, tape, fasteners. Different types of smocking stitches-Cable, chain, diamond, honey comb, lattice. Seams and seam finishes- Plain, French, Flat-fell, Double-topstitched, Welt and different seam finishing methods. Creating fullness through different types of pleats, gathers, tucks, dart, shirring. Edge finishing – Straight edge finishing, curve edge finishing, decorative edge finishing. Plackets opening and finishing-One piece, two piece, binding. Taking body measurements

for different garments. Preparation of fabric for paper pattern layout, marking, cutting and stitching. Making basic block of bodice, sleeve and skirt and their adaptation. Drafting, cutting and stitching of – Apron, Panty, Bib, Romper, A line frock, Sari Petticoat.

Suggested ReadingS

1. Armstrong, H J, 1986, Pattern Making for fashion Design. Harper and Row, New York
2. Cooklin Gerry, 1991, Introduction to Clothing Construction
3. Horn M J, 1981, Second Skin, Hounghton Muffin, London.
4. Labanya M and Vastala R, 2004, Textbook of Fundamentals of Clothing Construction, ICAR, New Delhi.
5. Lewis V S, 1984, Comparative Clothing Construction Techniques. Surjeet Publication, New Delhi.
6. Kefgen M and Phyllis T S, 1971, Individuality in Clothing Selection and Personal Appearance. New York. The Macmillan Company
7. Readers Digest 'Complete guide to sewing' Reader Digest Association1977
8. Sannapapamma K J and Jahan S, TXAD111- Fundamentals of Clothing Construction. E course. Iasri.res.in.
9. Sakshi, 2013, Fundamentals of Clothing Construction. University Press, G. B. Pant University of Agriculture and Technology.
10. Thomos A J, 1993, The art of sewing, UBS Publishers, Bombay.
11. http://www.stitchrippers.com/forum/Topic/sewing-terminology.

Fundamentals of Ergonomics 2(1+1)

Objectives

1. To acquaint the students with the fundaments of ergonomics
2. To acquaint the students in gaining knowledge on importance of Ergonomics and learn how the body is used while performing different activities
3. To develop skill among students in onsite evaluation of ill effects of ergonomics risk factors

Theory

Introduction of Ergonomics - Definition, History of Ergonomics, Significance and Scope of Ergonomics; Domains of Ergonomics; Work physiology and fatigue; Systems of Human body-muscle system, Neuromuscular system, muscle contraction and muscle movement; Human compatibility factors - Anthropometry and anthropometric data, principles in the application of anthropometric data; Physical fitness; Work Posture - Fatigue - major body weights; MMS (Man-Machine - System), Manual Material Handling (MMH); Work related Health Problems- accidents, injuries, musculoskeletal problems, terminologies (RSI, WMSD, CTD, etc.).

Practical

Study of Anthropometric measurements- understanding different anthropometric data and terminologies and its usages; on-site postural studies; Determination of physical fitness.

Suggested Readings

1. Bridger R S. (1994). Introduction to Ergonomics. McGraw Hill.
2. Dalela S and Saurabh. (1999). Textbook of Work Study and Ergonomics, Standard Publ.
3. Grandgean E. (1978). Ergonomics of the Home. Taylor and Francis.
4. Ian Galer. (1982). Applied Ergonomics Handbook. Butterworths and Co.
5. Panero J and Zelnik M. (1979). Human Dimension and Interior Space. Whitney Library of Design.
6. Singh S. (2007). Ergonomics Interventions for Health and Productivity. Himanshu Publ.

Theoretical Approaches to Parenting 2 (2+0)Objectives

1. To know the parenting roles and practices
2. To know positive and maladaptive parenting
3. To know the effects of parenting style and practices on child developmental outcomes

Theory

Positive Psychology, Parenting Style, Parenting Practices, and Parenting Roles parent-child transactions, influential factors, family orchestrated child experiences, information needs, Biological, social and Psychological theories, Attachment Theory approach, Behavioristic approach Social Learning approach, Ecological systems approach, Parental role theory approach, Disciplinary theory, Scaffolding approach (Vygotsky), Self-determination approach, Family systems theory approach etc.

Suggested Readings

1. Charney, D.S., 2004, Psychobiological Mechanisms of Resilience and vulnerability.
2. Carbonell, D.M., Reinherz, H.Z., Giaconia, R.M., Stashwicks, C.A., Paradis, A.D. and Beardslee, White J.M and Klien D.M., 2008, Family theories 3rd edn, Sage publications.
3. Damon, W., Sigel, I.E. and Renninger, A., 1998, Handbook of Child Psychology, 5th edn, John Wiley and Sons, Inc., New York.
4. Shonkoff, J.P and Meisels, S.J., 2009, Handbook of early childhood intervention, 2nd edn, Cambridge University Press, New York.

Personality Development 2(1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theoriesand principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship

2. To expose the student to various aspects of establishment and management of a small business unit

3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form

of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practicals

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Desai, Vasant 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
4. Grover Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
6. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co.
7. Mehra P. 2016. Business Communication for Managers. Pearson India, New Delhi.
8. Pandey M and Tewari D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
10. Singhal R K. 2013. Entrepreneurship Development and Management, Katson Books.
11. Tripathi P C and Reddy P N. 1991. Principles of Management. Tata McGraw Hill.

Environmental Studies and Disaster Management 3(2+1)

Objectives

1. To expose and acquire knowledge on the environment and
2. to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and

function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (g) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi

4. Miller, Tyler and Spoolman, Scot. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

5. Parthiban, K., Vennila, T., Prasanthrajan, S., Umesh, M. and Kanna, S. 2023. (In Press). Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.

6. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008

7. Prasanthrajan, M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.

8. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India.

National Cadet Corps (NCC-II) 1(0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness programmes

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs;
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

Importance and role of youth leadership; Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies; Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations; Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Skill Enhancement Courses (SEC-II module) 4 (0+4)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-certificate, they can work with cakes and pastries shops/ units, patchwork and quilting units, home textile units, housekeeping job services, event management units, childhood clinics, audio-visual aids production units/shops, ICT service providers, etc. or can go for self-employment.

Indicative options for SEC-II *(any one module to be selected)*

Module	Course	Credit Hours
Bakery and Confectionary Management- II	Cakes and Pastries	2 (0+2)
	Chocolate Making	2 (0+2)
Textile Design and Embellishment- II	Indian Embroideries	2 (0+2)
	Quilting and Patchwork	2 (0+2)
Event Management and Housekeeping- II	Housekeeping and Service Management II	2 (0+2)
	Event Planning and Management	2 (0+2)
Childhood Development and Assessment- II	Infant Stimulation Practices	2 (0+2)
	Health Practices in Early Childhood	2 (0+2)
Extension Education for Community Development- II	Computerized Instructional Aids Production	2 (0+2)
	ICT and New Media	2 (0+2)

Module on Bakery and Confectionary Management- II

Cakes and Pastries 2 (0+2)

Objectives

1. To enable students to learn the basics of producing cake and pastry techniques
2. To acquaint the students with newer technologies and machinery used in product development
3. To impart knowledge about commercialization of cake and pastry

Practical

Cake and Pastry – Role of ingredients, cake and making Method's, Cake and pastry Mixing Method's Characteristics of cake and pastry, Role of ingredients in sponge goods. Type of cake - Eggless sponge making, Fruit making, Pound making, Ganache making, marbled making, Swiss roll making. Cake and pastry packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of cake and pastry. Storage of cake and pastry – slightly cool, dry, dark place. Visit to a cake and pastry industry. Project planning for financial assistance for a small-scale industry on cake and pastry making and writing report.

Suggested Reading

1. Arora A.K. 2007.Food Service and Catering Management. APH Publishing Corporation, New Delhi.
2. Bali, Parvinder S. 2018. Theory of Bakery. Oxford publishing.
3. Cauvain, Stanley P. and Young, Linda S. 2007. Technology of Bread Making, Springer.
4. Chakrabarty M M. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
5. Dendy DAV and Dobraszczyk BJ. 2001. Cereal and Cereal Products. Aspen.
6. Edwards W.P. Science of bakery products, RSC, UK, 2007
7. Matz, Samuel A. 1992. Bakery Technology and Engineering, 3rd edn, Chapman and Hall, London.
8. Samuel A. Matz., Equipment for Bakers, Pan Tech International Publication. 1988.

Chocolate Making 2 (0+2)

Objectives

1. To enable students to learn the basics of producing chocolate making and packaging
2. To acquaint the students with newer technologies and machineries used in product development
3. To important knowledge about commercialization of chocolates

Practical

Chocolate – basic formulation, preparation of types of chocolate like -basic chocolate, liquid filled chocolate, semi-sweet chocolate, bittersweet chocolate, dark chocolate. Chocolate packaging, Labelling, Packaging material- plastic material, paper material, aluminium material

Packaging type- banding, foil packing, sleeve packing, twist packing. Technique use in chocolate packaging process- foil wrapping, fold wrapping, coin wrapping, bar wrapping. Sensory evaluation

direct method - appearance, odor, flavor, taste, and texture Indirect method – single sample test, triangle test, 9-point hedonic scale and the paired comparison test. Consumer validation. Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of chocolate. Storage of chocolate – slightly cool, dry, dark place.

Shelf life of chocolate - parameters of shelf life, type of deterioration, Shelf-life dating. Method to determine shelf life of chocolate – direct method, challenge test, accelerate shelf-life test. Visit to chocolate industry. Project planning for financial assistance for a small-scale industry on chocolate making and report writing.

Suggested Reading:

1. Baptista, Iuri. 2021. International Journal of Gastronomy and Food Science 24, 100340.
2. Edwards, W.P. 2007. Science of bakery products□, Published by The Royal Society of Chemistry, UK,2007
3. Jackson, E.B. 1995. Sugar Confectionery manufacture-(Ed), 2nd Edition, Blackie Academic and professional, Glasgow,
4. Maricel, E. and Presilla. 2009. The New Taste of Chocolate, Revised: A Cultural and Natural History of Cacao with Recipes. Ten Speed Press; Revised edition (24 November 2009).

Module on
Textile Design and Embellishment- II

Indian Embroideries 2 (0+2)

Objectives

1. To learn the characteristic features/designs of the traditional embroideries of different states of the India
2. To develop an understanding of the methods and materials used in different traditional embroideries
3. To develop an understanding of the techniques of traditional embroideries of India

Practical

Historic perspective, classification and importance of traditional Indian Embroideries Documentation of motifs of traditional Indian embroideries of different States of India- and sample preparation of traditional Indian embroideries -Kashida of Kashmir, Chamba Rumal, Phulkari and Bagh of Punjab, Embroideries of Gujarat, Chikankari and Zari work of Uttar Pradesh, Kanthas of Bengal, Toda Embroidery of Tamil nadu. Kasuti of Karnataka, Patchwork of Bihar and Orissa and Folk embroidery of Rajasthan. Creative projects: Preparation of one article by adapting traditional motifs and embroidery in contemporary textiles. Visit to National craft museum and exhibition/art galleries.

Suggested Readings

1. A Compendium of Indian Handicrafts and Handlooms covered under Geographical Indications (GI), Ministry of Textiles, Govt. of India, New Delhi, 204p.

2. Kale, Smita. Kashmir to Kanyakumari Indian Embroidery: State. State Embroidery of India. Publisher- Author House, ISBN -10: 1456779532, ISBN -13: 978-1456779535
3. Naik, S.D. (2012). Traditional Embroideries of India, New Delhi: APH Publishing Corporation.
4. Naik, S.D. (1997). Folk embroidery and traditional handloom weaving, New Delhi: APH Publishing Corporation.
5. Pauline, B. (2016). Encyclopedia of Embroidery Techniques, A unique visual directory of all the major embroidery techniques, plus inspirational examples of traditional and innovative finished work, 176 p, ISBN-**10: 1782214755**
6. Rai, I. (2008). Indian Embroidery and Textiles (First Edition). Jodhpur: Books Treasure.

Quilting and Patchwork 2 (0+2)

Objectives

1. To develop awareness among students about Quilting techniques
2. To develop skills in various designs of Quilting and Patchwork

Practical

Patch Work: Definition, Different styles of Patchwork Techniques- Pieced Patchwork, Shell Patchwork, Suffolk Puffs, Crazy Patchwork, Log Cabin Patchwork, Strip Patchwork, Seminole Patchwork, Folded Star Patchwork, Mayflower Patchwork and Pleated Patchwork, Applique: Definition, Various Styles of Applique Techniques, Standard applique, Applique Perse, Reverse applique, Padded applique, folded applique, Shadow applique, Lace appliqué, Quilting: Definition, Various Styles of Quilting, Wadded Quilting, Padded Quilting, Corded Quilting, Shadow Quilting, Preparation of two commercially viable article using above techniques.

Suggested Readings

1. Allen, W.H. 1985. Mc-calls big book of Quilts and Other Treasures, London Fall Cheryl.
2. Happy Quilts, Storling Publisher, New York. 1994
3. Villasenor, David. Indian Designs: For Use as Quilt Patterns, Needlepoint, Applique, Machine and Hand Embroidery, Clothing, Trapunto, Fabric Painting, Crafts Projects ... Other Uses (Native American). Publisher- Naturegraph Pub; ISBN-10- 0879611227; ISBN-13-978-0879611224

Module on Event Management and Housekeeping- II

Housekeeping and Service management-II 2 (0+2)

Objectives

By the end of the course, the student must be able to:

1. Understand role and responsibility of housekeeping department
2. Discuss relationship of housekeeping with other departments
3. Demonstrate an understanding of housekeeping basic planning activity and its organization
4. Understand and analyze housekeeping standards together with safety and security aspects
5. Demonstrate the creativity on housekeeping standards and trends

Practical

Understanding the role of housekeeping and its relationship with other departments. Housekeeping department and its role and responsibility. Housekeeping organization chart. Positions and job descriptions in housekeeping department. Developing a schedule outlining the housekeeping department and their roles and responsibility in various types of organizations. Developing a housekeeping organization chart with positions and job descriptions in housekeeping department in various types of organizations. Different types and importance of keys- section key, master key, floor key and grand master key. Key of executive officers and public areas, and computerized key. Understanding the role of housekeeping and its relationship with other departments -Front office. Food and beverage, Engineering departments. Planning and organizing housekeeping department Planning the work in housekeeping department -Area inventory, Frequency schedule. Performance standard, Productivity standard, Supply and equipment inventory level. Housekeeping standards / trends Housekeeping standard building. standard set up. Human resource and training employees in housekeeping. Staffing and training employees. Motivating employees.

Suggested Readings

1. Casado, M. (2000) Housekeeping Management. New York: John Wiley and Sons, Inc.
2. Martin, R. (1998) Professional Management of Housekeeping Operations. (3rd edn). New York: John Wiley and Sons, Inc.
3. Kappa, M., Nitschke, A. and Schappert, P. (1995) Housekeeping Management. New York: Educational Institute of the American Hotel and Motel Association.

Event Planning and Management 2 (0+2)

Objectives

By the end of the course, the student must be able to:

1. Understand event planning and management, its scope and significance
2. Know about the stages and domains of event management
3. Understand the process of planning and management

Practical

Developing a SWOT analysis of identifying and conducting an event. Identify various corporate events. Identifying and develop a schedule for any one event for a college event, themed celebration, festival. Develop a plan for budget / sponsors / fundraising / marketing strategies for the identified events. Listing of fundamentals of corporate hospitality, Study event specifications of Celebrity events and Award Ceremonies, Destination weddings. Establish a plan for risk assessment and management within the Event Laws and Administration and Health and Safety Requirements. Plan an event for themed celebration, Festival, Record outcome of events and evaluate the event through SWOT analysis, report on the success and weakness of the events.

Suggested Readings

1. Berridge, G. (2006) Event Design and Experience. Oxford: Butterworth - Heinemann.
2. Bowdin, G., McDonnell, I., Allen, J. and O'Toole, W. (2010) Events Management 3rd edn. Oxford: Butterworth - Heinemann.

3. Gera, Vineet. (2012) Event Management and Planning. Atlantic Publishers and Distributors.
4. Getz, D. (2007) Event Studies: Theory, Research and Policy for Planned Events. Oxford: Butterworth - Heinemann.
5. Goldblatt, J. (2010) Special Events: A New Generation and the Next Frontier. New York: Wiley.
6. Judy Allen. (2009) Event Planning Ethics and Etiquette: A Principled Approach to the Business of Special Event Management, Wiley (first published 2003).

Module on Childhood Development and Assessment- II

Infant Stimulation Practices 2 (0+2)

Objectives

1. To understand the need for providing stimulation to infants
2. To learn the skills of providing stimulation

Practical

Stimulation for Growth and development of neonate -Sensation and perception, for Newborns at risk-Preterm, Low birth weight, Respiratory distress syndrome. Stimulation for Physical Development during Toddlerhood, Muscle Control, motor skills. Stimulatory learning environments at home and early childhood child care and education centers. Current and conventional practices of stimulatory learning. Innovative ideas for planning and execution of customized Programs / activities for infants.

Suggested Readings

1. Boyd D and Bee H (2011) Lifespan Development. Pearson.
2. Kail R V and Cavaraugh J C (2004) Human Development - A Life Span View.
3. Santrock J W (2006) Life Span Development. McGraw Hill.
4. Santrock J (2014). Lifespan Development. McGraw Hill.
5. Steinberg L, Bornstein M H, Vandell D L and Rook K S (2011). Lifespan Development. USA: Wadsworth.

Health Practices in Early Childhood 2 (0+2)

Objectives

1. To learn about the importance of health and factors affecting health
2. To promote health and hygiene in children
3. To reduce and prevent the incidence of underdevelopment and diseases in young children
4. To plan need-based programs to address health issues during early childhood
5. To educate parents/caregivers/ ECE Teachers on good health practices

Practical

Importance of child's health - factors affecting child health; Important child health indicators- NMR, IMR, CMR (under 5 years); Health care practices during neonatal stage, infancy and

childhood period; Nutrition and health; Health assessment techniques in children; ECE Centres and Child's health; Integration of Health care with educational and social services; Identification of common health problems in children; Planning and organizing parent/community health education Program; Review of health Programs and policy, Digital addiction and child health; Eating disorders and child health; Health care practices in rural /urban/tribal families; Case study of preschool child; Studying health care practices in children; Report writing and presentation; Recommendation to parents/caregivers/health care professionals and ECE educators.

Suggested Readings

1. Charles Nechtem Associates. 2021. EAP: 800-531-0200.
2. Corbett, A., Gratale, D., Ellis, W., et al. 2014. Organization(s): Nemours Date.
3. Dutt. S. Understanding children. Anmol Publications pvt.ltd.
4. Hurlock, E.B. 1978. Child development. 6th edn. Tata Mc graw hill education (India)
5. Nandha, V. K. 2002. Priniciples of child development. Anmol publications. Pvt.ltd.
6. National Center on Health, Behavioral Health, and Safety 888-227-5125 health @ ecetta.info Page 25 of 25.
7. Mazar, J.E. 2017. Learning and Behaviour. 8th edn. Rantiledge publications.
8. Papalia, D.E., Olds, S.W. and Feldman, R.D. 2004. Human development. 9th edn. Mc Graw Hill Education (India).
9. Santrock, J.W. 2011. Life span Development. 12th edn. McGraw Hill Education (India).
10. https://childcareta.acf.hhs.gov.
11. https://www.who.int/health-Topic/child-health.
12. www.ruralhealthinfo.org/toolkits/child-health/1/overview.www.ashaweb.org/wp-content/uploads/2014/08/Childhood-Obesity-Prevention-Strategies-for-Rural-Communities.pdf.

Module on Extension Education for Community Development- II

Computerized Instructional Aids Production 2 (0+2)

Objectives

1. To develop an understanding about the software used for production of computerized information material
2. To build competency in application of different software tools for production of instructional aids

Practical

Familiarization with the parts of computer, Software for creation of instructional materials: MS Word 2020/latest version – Getting started, editing documents, proofing tools, text formatting, formatting document, using templates, creating tables and charts. Using reference and review option in word and WPS for smartphones and creating Google forms, MS PowerPoint 2020/latest version – Getting started, working with text in slides, working with charts, printing, animating custom shows and adding hyperlinks. Recording PPT's screen capture recordings and e-presentations, MS-Excel 2020/latest version - Getting started, using workbooks, entering data, editing data,

formatting worksheet, working with range of cells, creating formulas and functions, working with charts, object linking and embedding. Importance of colours in designing of visual aids. Illustrator/ latest designing software – Familiarization and working with software, Planning and production of selected instructional aids, Familiarization of menus required for designing various publications and print material. Planning and designing of Visiting Card, Customized cards for gift hampers, Leaflet, Folder, Poster, Brochure, Booklet, Newsletter, and Magazine.

Suggested Readings

1. Jain S., Geetha M. and Kratika. 2012. Computer Course Windows 7 with MS Office 2010, 1st edn. BPB Publications, New Delhi – 110 001.
2. Murthy G.R.K., Reddy K.M. Ramarao D., Rao V.K.J and Kumar V.V.S. 2012. Resource Material on Innovative Approaches to E- Learning, National Academy of Agricultural Research Management, Rajendranagar, Hyderabad, 500 030.
3. Rajaraman V. 2001. Fundamentals of computers, 3rd edn. Prentice-Hall of India private limited, New Delhi – 110 001.
4. Sarvanan R., Nesa Rani P.M., Madhava Rao V and Rao V.K.J. 2015. AEM -204 Information and Communication Technology in Agriculture, National Institute of Agricultural Extension Management, Rajendranagar, Hyderabad – 500 030, India.
5. Simonson M. 2014. (a), 37th Annual Proceedings - Jacksonville: Practice of Educational Communications and Technology Vol. 1 and 2. Nova Southeastern University, North Miami Beach, Florida.
6. Simonson M. 2015. (b). 38th Annual Proceedings, Indianapolis: Practice of Educational Communications and Technology, Vol. 1 and 2. Nova Southeastern University, North Miami Beach, Florida.
7. https://www.renderforest.com
8. https://www.socrative.com

ICT and New Media 2 (0+2)

Objectives

1. To provide hands-on experience on application of ICT tools and devices
2. To develop an understanding about the e-learning tools
3. To build competency in usage of different digital platforms for dissemination of information

Practical

e- Learning Systems – learning objects development. e-Learning Systems –fundamental characteristics of learning objects, typical components of learning objects. e-Learning Systems – typical components of learning objects. Role of Internet in e-Learning – computer networking, domain names and URL, ISP, types of internet protocols. Social media for e-Learning under Web 2. Platform – YouTube, Blogs, Vlogs, Virtual Classrooms. Social Networking Sites – Facebook, LinkedIn, WhatsApp. Open access resources – e-books, e-Journals and e- newspapers. Open access resources – e- magazines, Web portals. Important online technologies for creation of computerized learning materials, Screen capture, Render Forest. Lucid Charts, Kids inspiration, Sketch Up, Classtools.net. Mind42, Slide share. Socrative, Testmoz, Quiz Star; Photoshop CS5 – Getting started, working with

selections, painting and editing, layers, channels, masks and animation, Web site designing concept, HTML, interactive.

Suggested Readings

1. Reinhard Robert and Dowd Snow. 2004. Macromedia Flash Mx 2004 Bible. Wiley.
2. Vaghan Tay. 2002. Multimedia- Making it Work. 5th edn. Tata McGrawHill.

Post-II Semester

Internship (only for exit option for award of UG-Certificate) 10 (0+10)

Objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop competency and confidence during hands on experience

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as Experiential learning units, prototype production facilities, etc.) or in related cottage industries, local artisans/craftsmen, handicraft units, bakery shops, fruits and vegetable processing and preservations centre, or related organisations involved in the activities of the respective domain. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Food Packaging and labelling 2 (1+1)

Objectives

This course will enable students to:

1. To impart knowledge of various areas related to food processing and packaging
2. To develop skills required in various industries, research labs and in the field of food and human health
3. To enable the students to understand packaging materials and effective packaging processes

Theory

Introduction, Importance and Role of packaging in extending shelf life of foods, packaging materials: Use of paper, glass, metals and plastics as a packaging material, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches. Different forms of packaging, Rigid, semi-rigid, flexible forms of packaging, Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods, beverages, microwave food products. Printing of packages, Barcodes and other marking, Legal requirements of packaging materials and product information. Properties of packaging materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, methods of testing and evaluation; barrier properties of packaging materials; theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate and its measurement, water vapor transmission rate and its measurement. Testing of package performance, Transport worthiness tests, Safety aspects/ assessment of food packaging materials. Aseptic packaging of foods: sterilization of packaging material, food contact surfaces and aseptic packaging systems. Modern Packaging Techniques-Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Active food packaging – definition, scope, physical and chemical principles involved, Edible films and coatings. Microbiological aspects of packaging materials. Regulation related to Hazardous Packaging. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food. Standard packages - package laws and regulation – general guidelines on giving declarations – FSSAI. Packaging equipment and machinery- Vacuum packaging machine, CA and AMP; MA packaging machine, Gas packaging machine, Seal and shrink-packaging machine. Form and amp; fill sealing machine, Aseptic packaging systems, Retort pouches, bottling machines, Carton making machines, Basic Concept of Printing on Packaging, Package printing machines.

Practical

Familiarization of different types of packaging material. Testing of packaging materials like thickness, GSM, grease resistance, bursting strength, tearing resistance, Water vapour transmission rate (WVTR), puncture resistance. Vacuum packaging and determination of storage life Testing the compression strength of the boxes. Packaging of food material in seal and shrink-packaging machine and study its shelf life, testing of strength of glass containers by thermal shock test, testing of strength of filled pouches by drop tester. Packaging of powder foods and estimation of shelf-life Visit to a food packaging plant.

Suggested Readings

1. Robertson, G.L. 2016. Food Packaging: Principles and Practice, Third Edition. CRC Press.
2. Robertson, G.L. 2009. Food Packaging and Shelf Life: A Practical Guide. Tailor and Francis. CRC Press.
3. Ruben Hernandez, Susan E., Selke, M. and Culter, John D. Plastics Packaging: Properties, Processing, Applications, and Regulations by FSSAI.
4. Rui M.S. Cruiz. 2019.Food Packaging: Innovations and Shelf-life. CRC Press.

Pattern Making and Draping 3 (1+2)

Objectives

1. To enable students to develop patterns for designer garments
2. To develop understanding about basics of pattern making and draping
3. To upgrade skills for commercialized apparel manufacturing using advance patternmaking techniques
4. To develop skills in obtaining perfect fit and create harmony between the fabric and garment design

Theory

Flat pattern: Terminology, tools, applications and limitations. Anthropometric measurements: Importance, standardization and standard measurement charts of children and adults. Pattern development process: Design analysis, plotting, alteration of basic patterns and development of production patterns for fabric layout. Principles of patternmaking: Dart manipulation, added fullness and contouring. Patternmaking techniques: Slash-spread and pivot-transfer. Draping: Terminology, tools, applications and limitations. Basic draping techniques for bodice front and back, skirt front and back. Application of dart manipulation, added fullness and contouring principles in draping. Factors affecting patternmaking and apparel construction using special fabrics: Stretch fabrics, knits, checks, plaids, velvet and lace etc. Fitting: Principles of fitting, standards for good fit, common fitting problems and their remedies. Pattern grading: Importance, terminology and techniques.

Practical

Taking measurements: Circumference, horizontal and vertical measurements. Preparation of basic pattern set- bodice front and back, skirt front and back and sleeve. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through slash-spread and pivot-transfer techniques to design patterns having single-dart series, two-dart series, tuck-darts, graduated, radiating and parallel darts, pleats, flare, gathers, princess stylelines. Development of design patterns through flat patternmaking technique: Design analysis, adaptation of basic patterns through added fullness in different forms and at various locations. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through contouring to empire, surplice, off-shoulder and halter designs. Preparation of paper patterns for different yokes, collars, necklines, sleeves and skirts. Development of design patterns through flat patternmaking technique for six garments incorporating various style features- two of each principle of patternmaking. Construction of three garments using developed design patterns- one each of dart manipulation, added fullness and contouring. Preparation of muslin for draping, development of foundation block for upper and lower garments. Designing of different garments through draping using dart manipulation. Designing of different garments through draping with added fullness. Designing of different garments through draping using contouring. Designing upper garments with different yokes, collars, built-up necklines and cowls through draping. Development of design paper patterns of six garments of draped patterns incorporating various style features - two of each principle of patternmaking. Construction of three garments using developed design patterns of draped patterns- one each of dart manipulation, added fullness and contouring for casual, formal and party wear. Assessment of constructed garments for fitting. Pattern grading: Grading of basic

blocks through draft grade and track grade systems of grading, pattern grading using different zero points. Projection of work. Visit to apparel manufacturing units and fashion institutes.

Taking measurements: Circumference, horizontal and vertical measurements. Preparation of basic pattern set- bodice front and back, skirt front and back and sleeve. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through slash-spread and pivot-transfer techniques to design patterns having single-dart series, two-dart series, tuck-darts, graduated, radiating and parallel darts, pleats, flare, gathers, princess style lines. Development of design patterns through flat patternmaking technique: Design analysis, adaptation of basic patterns through added fullness in different forms and at various locations. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through contouring to empire, surplice, off-shoulder and halter designs. Preparation of paper patterns for different yokes, collars, necklines, sleeves and skirts. Development of design patterns through flat patternmaking technique for six garments incorporating various style features (two each of dart manipulation, added fullness and contouring). Construction of three garments using developed design patterns (one each of dart manipulation, added fullness and contouring) and assessment of their fitting. Preparation of muslin for draping, development of foundation block for upper and lower garments. Designing of different patterns through draping using dart manipulation. Designing of different patterns through draping with added fullness. Designing of different patterns through draping using contouring. Designing upper garment patterns with different yokes, collars, built-up necklines and cowls through draping. Designing and Construction of three garments using developed design patterns of draped patterns (one each of dart manipulation, added fullness and contouring for casual, formal and party wear) and assessment of their fitting. Grading of garment pattern (any one of the constructed garments).

Suggested Readings

1. Amaden-Crawford, C. (2018). The Art of Fashion Draping. Bloomsbury Publishing Inc.USA.
2. Bane, A. (1996). Creative Clothing Construction. McGraw-Hill Publication, USA.
3. Bane, A. (1972). Flat Pattern Design. McGraw-Hill Publication, USA.
4. Bray, N. (2003). Dress Fitting: Basic Principles and Practice. Classic Edition, Blackwell Publishing.
5. Cooklin, G. (1991). Pattern Grading for Women's Clothes. Blackwell Publishing.
6. Goulbourn, M. (1998). Introducing Fashion Cutting, Grading and Modelling. Batsford Publications, UK.
7. Handford, J. (2003). Professional Pattern Grading for Women's, Men's and Children's Apparel. Fairchild Books, New York.
8. Kiisel, K. (2020). Draping: The Complete Course. Laurence King Publishing.
9. Mee, J. and Purdy, M. (1987). Modelling on the Dress Stand. BSP Professional Books.
10. Tate, S.L. (2003). Inside Fashion Design. 5th edn. Prentice Hall Publishing Co.
11. Taylor, P.J. and Shoben, M.M. (1990). Grading for the Fashion Industry. Stanely Homes Ltd.
12. Winfred, A. (2015). Metric Pattern Cutting for Women's Wear. Blackwell Publishing.

Computer Aided Interior Designing –I 3 (1+2)

Objectives

This course aims to help the students

1. To get oriented with use of AUTOCAD software
2. To understand various draw and edit commands in AUTOCAD software
3. To draw the furniture templates through AUTOCAD
4. To draw the structural building features through AUTOCAD
5. To develop conceptual drawings through AUTOCAD

Theory

Introduction to AUTOCAD: Drawing templates, dialogue boxes - Toolbar, Difference between Paper drawing and CAD drawing - AutoCAD co-ordinate system - Absolute and Relative, Methods of using tools in AutoCAD - Introduction to 2D drawing tools - line, polyline, polygon, rectangle, Ellipse - Introduction to modify tools- Copy, mirror, offset, Array, Move, Rotate, Scale, stretch, extend, Trim, Break, Chamfer, Fillet - Adding Text to drawings, text styles, Dimension tools and styles, Methods of adding dimensions to drawings - Blocks and inserts : Methods of inserting drawings.

Practical

Orientation about Auto CAD software through demo mode- Opening the software, Opening the document and setting up to start drawing - Use of Auto CAD Co-ordinate system – Relative and Absolute - Demo of using basic drawing tools – Line, polyline, polygon, rectangle, ellipse - Demo of use of modify tools – Copy, mirror, offset, rotate, trim, extend, chamfer, filter, array, move, break - Developing different 2-D features in drawings through AUTOCAD- Door, windows, furniture templates, stairs - Adding Text to drawings, text styles.

Suggested Readings

1. Fiorell Joseph A.C. CAD for Interiors Basics. John Wiley and Sons Inc. https://www.flipkart.com/cad-interiors-basics/p/itmczz9jmywztxuf
2. Kirkpatrick Beverly L and Kirkpatrick James M. 2000. Auto CAD for Interior Design and Space Planning using Auto CAD 2000. Peach pit press
3. Moss Elise. 2019. Auto CAD 2020 Fundamentals SDC publications
4. Muccio Dean. 2020. Auto CAD 2021 for the Interior Designer. SDC publications
5. Shrock Cheryl R and Heather Steve. 2019. Auto CAD Pocket Reference. 8th edn. Best Seller Publication.
6. Zeid Ibrahim and Sivasubramanyan R. 2009. CAD/CAM: Theory and Practice Special Indian edition. McGraw Hill Education.

Early Childhood Education 3(2+1)

Objectives

1. To orient the students about significance of ECE for accelerating holistic development of children

2. To enhance knowledge and skills of the students for planning program and its execution in ECE centres
3. To sensitize students about significance of inclusive ECCE and also about involving parents and community in ECE program

Theory

Early Childhood Education - Meaning, characteristics and significance of early childhood education.History of its evolution, abroad and in India, -National ECCE policy 2020 - application of Western and Indian educational philosophies to early childhood education - Recent trends and challenges in Early Childhood Education - Concept of learning- definition, essential features, types of learning, laws of learning, principles of learning ; sensations, perception, imagination, attention and memory, remembering and forgetting, Intelligence-reasoning and thinking, effortful control, problem solving, information processingand learning environment- Motivation- definition, types, modes of motivation, relationship of motivation with learning and performance - Performance evaluation – meaning of evaluation/ testing, evaluation of student's performance - Types of tests used in classroom evaluation - program planning in ECE- Theory of play, Development of play stages, Importance of play, Steps and types of program planning, Significance of Play way method in ECE, Activities to promote all round development of children in early childhood- cognitive, language, socio-emotional and motor development, Developing key characters in children: Empathy, Adaptation, Boldness, Creativity, Diligence, Patience, Responsibility, Self-reliance, Resilience, Resourcefulness, Positive Self-esteem, Integrity, Humility, Tolerance, punctuality etc., role, qualities and responsibilities of an early childhood personnel, maintenance of registers and records; promotion of inclusive ECCE; involvement of parents and community in ECCE. Guidance to parents on activities to promote child's learning / early identification of learning problems.

Practical

Observation and recording of activities in ECE center. Analyzing effect of reinforcement, motivation, discipline on learning. Developing and conducting activities to promote all round development- Gross and fine motor skills, cognitive skills, language skills, creativity and socio emotional skills. Preparation of suitable creative/innovative teaching learning material used for preschool children. Application of theories of classroom teaching. Application of different methods of evaluating performance and interpretation.

Suggested Readings

1. Catherine E. Snow and Susan B. Van Hemel, eds.; Early Childhood Assessment: Why, What, and How by the National Research Council. The National Academies Press, 2008.
2. Early chidhood Care and Education (ecce): Foundations of Learning NEP, 2020, Department of Elementary Education, NCERT, New Delhi
3. Early Childhood Care and Education, Senior Secondary Course, 376, National Institute of Open Schooling ISO9001:2000 Certified (An autonomous organisation under MHRD, Govt. of India) A-24-25, Institutional Area, Sector-62, NOIDA-201309 (U.P.)
4. Website: www.nios.ac.in, Toll Free No: 18001809393
5. Eliason, C. and Jenkins, L. (1990). A Practicum Guide to Early Childhood Curriculum, 4th edition, London: Merrill Publishing Company.

6. Grewal, J.C. (2000). Methods and Materials of Nursery Education, 4th edition revised, Delhi: Doaba House, Book Sellers and Publishers
7. Grewal, J.S. (1984). Early Childhood Education, Foundations and Practice, Agra: National Psychological Corporation, Modern Printers.
8. Human development and Family studies, Unit III, NCERT, New Delhi
9. http://ncert.nic.in/textbook/pdf/lehe107.pdf.
10. Kostelnik, M.J., Soderman, A.K., and Whiren, A.P. (2007). Developmentally Appropriate Curriculum, Best Practces in Early Childhood Education, 4 th Edition (pp. 13-29). New
11. Jersy: PEARSON, Merrill Printice Hall.
12. Mohanty, J. and Mohanty, B. (2000). Early Childhood Care and Education, New Delhi: Deepand Deep Publications Pvt. Ltd.
13. National early childhood care and education (ecce) Curriculum framework, ministry of womenand child development.
14. Programmes, http://ecoursesonline.iasri.res.in/course/index.php?categoryid=100
15. The Preschool Curriculum, NCERT,2019.
16. Sinclair H (2004). Standards for Early Childhood Programmes in Centre based Child Care. Govt. of New Found Land and Labrador. Dept. of Health and Community Services.
17. UG Courses- Home Science - e-Krishi Shiksha, Early Childhood Development and Education.
18. http://ecoursesonline.iasri.res.in/course/index.php?categoryid=100 1
19. UG Courses- Home Science - e-Krishi Shiksha, Organization and Management of ECCD.

Extension and Rural development 3(2+1)

Objectives

1. To develop understanding regarding the extension support system
2. To impart knowledge on rural development programmes
3. To make them understand the role of extension agencies in rural development
4. To develop competency in working with the village people in line with the local and national rural development programmes

Theory

Extension Education: Concept and importance. Philosophy, principles and objectives. Evolution of extension education: Glimpses of pre- -independence era. Post-independence era. Community: Meaning and definition. Types of communities. Community mobilisation: - Meaning and importance. Leadership Development. Community development programmes: Concept, objectives, organization, activities. Strategies, achievement and failures. Community Science: Concept, significance and evolution of Community Science. Rural development: Concept, need, meaning, aim and functions. Role of Extension Agencies in Rural development. Panchayati Raj Institutions-Concept, power, role and responsibilities. Five-year Plans: Concept of Five-year plans (FYP). Planning Commission and NITI Aayog. Sustainable Development Goal (SDG). Rural Development programmes/ Organisations: SGSY (1999), NRLM (2011) - DDU-AY (Deen Dayal Antyodaya Yojana (DAY), IAY (1985)- Pradhan Matri Awas Yajana Gramin (PMAY-G), Mahatma

Gandhi National Rural Employment Gurantee Act (MGNREGA), Integrated Child Development Service Scheme (ICDS). Pradhan Mantri Social Security Schemes-Social Welfare and Social Safety Programme. Poshan Abhiyaan, National Health Mission (NHM), Swach Bharat Mission, Pradhan Mantri Kaushol Bikash Yojana (PMKBY). Din Dayal Upadhyaya Gramin Kausholya Yojana (DDUGKY)- Skill Development Programme, Sansad Adarsh Gram Yojana (SAGY), National Rurban Mission (NRuM). Atma Nirbhar Bharat Abhiyaan, District Water Management Agency (DWMA), Agricultural Technology Management Agency (ATMA). Role of International/National Organization: United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), Food and Agriculture Organization (FAO), Bill of Melinda Gates foundations Trust(BMGF). National Organization and State level organization: Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Integrated Tribal Development Project/Area (ITDA/ITDP). District Agricultural Advisory and transfer of Technology Centres (DAATTCs), District Rural Development Agency (DRDA), Farmer Producer Organization/Company (FPO/FPC), Self Help Groups (SHGs) in rural development. Evolution of Extension as broad-based extension with multiple stakeholders' i.e. govt/private/NGO/CSR funds.

Practical

Studying the village profile by visiting village: Establishing rapport with rural families and leaders. Use of Survey method: Identification of needs of rural mothers and Agriculture workers. Exploring Income Generating activities. Collecting information regarding the role of existing rural development program in operation with village area. Prepare a village profile based on collected information. Presentation of Report. Exposure Visit to: KVK. Exposure Visit to: PHC (for collecting information on health service specially to women and children). Exposure Visit to: DRDA. Exposure Visit to: AWCs. Exposure Visit to: Mahila Mandals/SHGs/Youth Club. Exposure Visit to: Cooperatives to make interaction program with Extension Professionals of the Institutions.

Suggested Readings

1. Azeez, N.P. Abdul and Akhtar Jawed S.M. (2016): Rural Development in India. Kalpaz Publications.
2. Chamola S.D. and Bharati Anirudha. (2018): Agriculture and Rural Development in India. Global Vision Publishing House.
3. Ganesan, R., Mohamed Iqbal, I. and Anandaraja N. (2019): Reaching the Unreached, ISBN: 978-8185211-57-2 (HB), Associated Publishing Company, Adivision of Astral International Pvt. Ltd., Ansari Road, Darya Ganj, New Delhi-110 002
4. Mondal, Sagar. (2018): Textbook of Agricultural Extension with Global Innovations, ISBN: 978-93-272-2877-9, Mrs. Usha Raj Kumar, Kalyani Publishers, B-15, Sector-8, NOIDA, New Delhi-110 002.
5. Mondal, Sagar. (2017): Fundamentals of Agricultural Extension Education (A complete Textbook for U.G. Students of Agriculture, Horticulture, Forestry, Fishery, Home Science and Dairy Faculties), ISBN 978-93-272-8203-0, Kalyani Publishers, Rajinder Nagar, Ludhiana-141 008.
6. Ray G.L. and Mondal Sagar. (2016): Rural Development. Kalyani. Publishers, Rajinder Nagar, Ludhiana-141 008.

7. Supe, S.V. (2017): A Textbook of Extension Education, Third Edition 2017, ISBN: 978-81-8321-431-5, Mrs. Geeta Somani, Agrotech Publishing Academy, J-38 Basant Vihar, Sector-5 Hiran Magri, Udaipur-313002 (India).

Rural Sociology 2 (2+0)

Objectives

1. To develop understanding about sociological concepts with special reference to rural community
2. To understand approaches to rural planning and status of rural women

Theory

Sociology and Rural sociology- Meaning and significance**;** Difference between rural, urban and tribal community; Indian rural social stratification: Caste and Class- Concept, Characteristics and difference, Changes in social stratification and implementation of constitutional provisions; Indian rural institutions- Social- Family and marriage (Nature, forms and changes), Economic, Political; Rural poverty: Meaning and causes; Religion : Functional significance of beliefs, traditions and customs; Rural social change: Concept, process and factors of transformation; Planned social change - Approaches to rural planning, improvement and transformation; Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

1. Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
2. Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. edn.
3. Doshi, S.L. (2007). Rural sociology. Delhi Rawat Publishers.
4. Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
5. Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first-aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports.
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Skill Enhancement Courses (SEC-III module) 2 (0+2)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-Diploma, they can work with food service provider, catering units, fashion design units, interior design shops, accessory designing units, ECCD centres, etc., etc. or can go for self-employment.

Indicative options for SEC-III module *(any one module to be selected)*

Module	Course	Credit Hours
Food Service Management - I	Quantity Cookery	1 (0+1)
	Traditional Indian Foods	1 (0+1)
Fashion Designing- I	Garment Designing	1 (0+1)
	Accessory Designing	1 (0+1)
Interior Design and Decoration - I	Interior Designing and Decoration I	1 (0+1)
	Floral Art and Design II	1 (0+1)

Module	Course	Credit Hours
Early Childhood Care and Education - I	Establishment of ECCE centers	1 (0+1)
	Program Planning and Execution in ECCE centers	1 (0+1)
Communication Technology and Journalism - I	Print Journalism	1 (0+1)
	Electronic Journalism	1 (0+1)

Module on
Food Service Management - I

Quantity Cookery 1 (0+1)

Objectives

1. Students will learn to produce various food items in quantity, food safety, and hygiene
2. Students will be able to learn menu planning, standardized recipes to be served to a large group of people, organizations

Practical

Equipment and Kitchen tools used in quantity cookery: Receiving and storage equipment, Production Equipment, Service equipment, Cleaning equipment. Kitchen Organization. Selection of raw material for quantity cookery. Regional foods for festivals. Snacks. Sweets. Gravies. Menus planning and quantity production. Food costing. Food safety –Food Handling, hygiene. Food waste management.

Suggested Readings

1. Arora, Krishna. 2011. Theory of Cookery. Frank Brothers and Co. Pvt. Ltd., New Delhi.
2. Bali, P.S. 2009.Food Production Operations.1st and 2nd edn. Oxford Publication.
3. Bali, P.S. 2011. Quantity Food Production Operation. Oxford Publication.
4. Bali, P.S. 2012. Food production management. Oxford Publication.

Traditional Indian Foods 1 (0+1)

Objectives

1. To know the traditional food preparations of different regions of India
2. To know the nutritive / therapeutic value of traditional Indian diets

Practical

Survey of region specific traditional food products having therapeutic / medicinal values. Calculation of nutritive value of traditional recipes and meals of the state. Planning and preparation of characteristic recipes of different states. Standardization of common recipes of North, East, South and West-Zone of the country. Preparation of nutritionally significant foods for physiological conditions in India. Preparation of festive food of the country.

Suggested Readings

1. Crusius, V.C. 1984. Quantity Food Management. Surjeet Publications, Delhi
2. Peckham, G.C. 1995. Foundations of Food Preparations. Prentice Hall, New Jersey.
3. West, B.B., Wood, L. Harger, V.F. and Shugart, G.S. 1997. Food Services in Institutions. John Wiley and Sons, New Delhi.

Module on
Fashion Designing – I

Garment Designing 1 (0+1)

Objectives

1. To develop awareness among students about garment designing
2. To develop skills in various fabric construction techniques

Practical

Selection of figure template for children, women and men. Designing of garments for children using different construction features: Yoke, gather, pleats, tucks, shirring, smocking, trimmings. Designing of garments for women using different construction features: collar, sleeve, and neckline. Designing of garments for men using different construction features: shoulder yoke, collar, sleeve, and cuff. Drafting and construction of following garments for women, men and children (Fancy frock, Salwar/ pyjama/pyjama, Kurta (gents)/kameez (ladies) and Night dress/ gown).

Suggested Readings

1. A.J. Chuter - Introduction to Clothing Production Management – Blackwell Science.
2. D.J. Tyles – Materials Management in Clothing Production - Blackwell Science.
3. Gerry Cooklin – Introduction to clothing Manufacture, Black Well Science.
4. Harold Carr and Barbara Latham – The Technology of Clothing Manufacture – Blackwell Science.

Accessory Designing 1 (0+1)

Objectives

1. To develop awareness among students about Accessory designing
2. To develop skills in construction of various accessories

Practical

Accessories: introduction and classification; footwear, hand bags, belt, jewelry, gloves, hats, scarves and umbrella; Designing of accessories for children, women and men; Selection of designs for construction of accessories; Accessories Construction for Children, Women, Men.

Suggested Readings

1. Harold Carr and Barbara Latham. 1992. Fashion Design and Product Development, Blackwell Science.

2. Mike Easey – Fashion Marketing. Blackwell Science
3. Peacock, J. 2000. Fashion Accessories- The Complete 20th Century Source Book. London. Thames and Hudson.
4. Meadows, C. S. 2003. Know your Fashion Accessories. New York. Fairchild books.

Module on
Interior Design and Decoration – I

Interior Design and Decoration I **1 (0+1)**

Objectives

This course aims to help the students

1. To understand the concept of elements and principles of design
2. To understand basic principles of illumination and application of natural lighting in interiors
3. To impart knowledge on working and managing of interior design as professional practice

Practical

Application of elements and of principles of design; colour concept: colour schemes and its cost estimation, colour scheme for problematic area; curtains and draperies, types of curtain material and hardware's, and its costing; lighting, types of light fixture, use of lights and lamps, lighting plan for problematic area; floor treatments and its type; wall treatment and its types; accessories for interiors; materials used for interior designing and decoration; indoor landscaping; flower arrangements; Auto CAD for interiors; visit to any residential and commercial building to study about materials used for interior designing and decoration.

Suggested Readings

1. Ch'ing, Francis D K and Binggeli, Cork. 2004. Interior Design Illustrated, Wiley Publications, New Jersey.
2. Dechiara Joseph, Panero Julius and Zelnik Martin. 2011. Time Saver Standards for Interior design and Space Planning, McGraw Hill, London,
3. Dechiara Joseph and Panero Julius. 2011. Standards for Interior Design and Space Planning, McGraw Hill Professional,
4. Diane Patrice and Tap Scott. 2000. Curtains, Draperies and Shades, Lane, Menlo Park, California.
5. Faulkner S and Faulkner R N. 1968. Inside Today's Home. Holt, Rinehart and amp; Winston.
6. Gordon Gary. 2015.Interior Lighting for Designers, 5th edn, Wiley Publishers.
7. Keeping Miles and Shiers David. 2017.Sustainable Building Design: Principles and Practice, Wiley Blackwell, 1stedition.
8. Mitton Maureen and Nystuen Courtney. 2016. Residential Interior Design - A Guide to Planning Spaces, Wiley Publication, 3rdedn.
9. Piotrowski Christine M. 2016. Designing Commercial Interiors, John Willey Publishers, 3rd edn.

10. Pratap R M. 2012 Interior Design Principles and Practice, Standard Publications, Delhi.
11. Seetharam P and Pannu P. 2009. Interior Design and Decoration, CBS, 1st edn, New Delhi.
12. Singh Gurcharan. 2017. Building materials, Standard Publishers Distributors, Delhi.

Floral Art and Design II 1 (0+1)

Objectives

This course aims to help the students:

1. To get oriented with modern and world over most popular techniques of floral craft
2. To understand aesthetics of Ikebana, Driftwood and Bonsai culture
3. To develop conceptual indoor landscaping designs for official, industrial, commercial and residential areas
4. To study dry flower technologies for developing long lasting floral craft
5. Get awareness about Ikebana flower arrangements, indoor plants and Bonsai Culture to convey through symbolism on how nature and art relate to daily living

Practical

Learning basic Ikebana techniques - Practice on concept and styles of classic ikebana flower arrangements such as Rikka, Nageire Bana, Seika, Moribana, Jiyūka - Study of various Indoor landscaping - plant scaping or interior scaping, greenery ideas to reimagine a professional space - office/ hotel, retail, hospital or lobby, Indoor plan maintenance work study. Designing various types of indoor landscape gardening such as Living Walls/Vertical Gardens, Table garden Dish or bowl garden, Green Garden, Stone Scaping, Holy Scape, Floating, Indoor Landscaping, Water Scapes. Cost estimation of indoor garden designing- Dry Flower Technology: Method of drying Flowers and Foliage, Freeze Drying, Glycerin Drying (Glycerining), Microwave/ Oven Drying, Water Drying, Embedding Oven Drying, Air Drying, sun drying, Press Drying, Skeletonizing, Potpourri, Sulphuring and Bleaching techniques. Cost estimation of dry flower techniques - Learning Styling techniques of bonsai, Bonsai aesthetics, Bonsai, Care and Culture of Miniature Trees - Designing useful and decorative Driftwood articles. Indian traditional ideas of floral decoration for floor, wall, windows and doors. Elements and colour theory in floral designing.

Suggested Readings

1. Adams, P. D. 1981. The Art of Bonsai. Ward, Lock and Co., London.
2. Adams, P. D. 1981. The Art of Bonsai. Ward, Lock and Co., London.
3. Averill, M. 1913. Japanese Flower Arrangement. John Lane Company, New York.
4. Conder, J. 1899. The Floral Art of Japan. Kelly and Walsh Ltd., Tokyo.
5. Douthitt, J. 2001. Bonsai: The Art of Living Sculpture. Rizzoli International Publications Inc., New York.
6. Gaines, R. L. 1977. Interior Plant scaping. Architectural Record Books, New York.
7. Kubo, K. 2006.Keiko's Ikebana: A Contemporary Approach to the Traditional Japanese Art of Flower Arranging. North Clarendon: Tuttle Publishing, North Clarendon, USA.
8. Lesniewicz, P. 1996. Bonsai in Your Home. Sterling Publishing Company, New York.

9. Scrivens, S. 1980. Interior Planting in Large Buildings. The Architectural Press, London.
10. Shofunotomo. 1982.The Essentials of Bonsai. Timber Press, Oregon.
11. Steere, W. C. 1972. Flower Arrangement: The Ikebana Way. Madison Square Press, Chicago, USA.

Module on
Early Childhood Care and Education – I

Establishment of ECCE Centres 1 (0+1)

Objectives

1. To gain practical experience in establishing different early childhood care and education centres
2. To learn about registration of ECCE centres

Practical

Concept, need, characteristics, functions and types of project planning. Ethical considerations in project planning. Types of child care and education programs - Objectives and services of different programs. Need assessment. Method and significance of need assessment. Funding agencies. Budget planning and accounts. Short term and long-term budget planning. Staffing and supervision. Legal and regulatory processes at national and international level. Registration and licensing. Infrastructure development- location, indoor and outdoor space requirements. Setting up the physical environment and facilities. Physical facilities ECCE centers- basic requirements; class room arrangements, care facilities- facilities for different budgets - Format for submission of proposal for physical facilities - Setting the learning environment. – classroom arrangements, equipment procurements- Short term and long term programs planning and evaluation. Preparing a project proposal. Need assessment in different settings for various programs, selection of locale and clientele. Layout planning for different program in rural and urban settings. Manpower, finance, infrastructure facilities and cost benefit analysis as input sources. Visit to various funding agencies like banks, cooperatives and other agencies and reporting about schemes and facilities offered by these agencies. Exploring current government programs to support self employment under various schemes. Report writing.

Suggested Readings

1. Dockett Sue, Arthur Leonie, Farmer Sue, Beecher Bronwyn and Deat Elizabeth. 2017. Programming and Planning in Early Childhood Settings**,** Cengage Australia.
2. Evans B E, Shurb B and Weinsten M. 1971. Day care. Beacon Press, New York.
3. Mohanty J and Mohanty B. 2000. Early Childhood Care and Education, Deep and Deep Publications Pvt. Ltd., New Delhi
4. Murlidharan R and Banerji V. 1969. A Guide for Nursery School Teachers, National Council of Education Research and Training, New Delhi.
5. NAEYC (National Association for the Education of Young Children). 2022. *Developmentally* Appropriate Practice in Early Childhood Programs Serving Children from Birth Through Age 8. 4th edn. Washington, DC: NAEYC.

6. Roopnarine Jaipaul and Johnson James E. 2015. Approaches to Early Childhood Education, (5th edn), Pearson India.

Programme Planning and Execution in ECCE Centres 1 (0+1)

Objectives

1. To gain practical experience of the planning of all aspects of different early childhood care and education centres
2. To develop skills for understanding developmental needs of young children belonging to early childhood years
1. To develop skills for planning and management of early childhood care and education programs
2. To provide practical experience in operating an early childhood education centre in urban and rural areas

Practical

Understanding principles of program planning - planning long and short-term program for various early childhood care and education centers - Issues and goals of curriculum planning - Principles of effective program planning. Importance of developmentally appropriate planning - Observing and recording developmental characteristics of children in various early childhood care and education settings. - Preparing developmentally appropriate activities for physical development, fine and large muscle coordination – developmentally appropriate activities for cognitive stimulation – activities for creative expression, language development - activities for socio emotional interaction – pre reading and pre writing activities – foundations for numeracy – activities for environmental awareness – science experiences – activities for body movements – developing self care, care of surroundings activities – effective use of material, mapping of material – developing classroom teaching learning accessories- activities for parent and community involvement – execution of all activities through practice teaching different age groups of children- conducting activities with parents and community- submitting records of observation of children's activities, Parent and community activities.

Suggested Readings

1. Aparajita and Chowhary Rita. 2016. Development Care and Education of Pre-School Children Discovery Publishing House, New Delhi
2. Brophy J.E., Good T.I. and Nedler S.E. 1975. Teaching in the preschool. Harper Row publisher, New York
3. Day B.1983. Early Childhood Education: Creative learning activities Macmilla Publishing Co., Inc. New York
4. Frost J. Lan and Kissinger J.B. 1976. The young child and the educative process. Holt, Rinechort and Winston, New York
5. Green Christopher. 2000. Beyond Toddlerdom, Vermilion Landon
6. Grewal J.S. 1984. Early childhood education: Foundations and practice. National Psychological Corporation, Agra.
7. Johnsons. 2004. Your Baby and Toddler. DK and Penguin Company, London

8. Leeper S.H, Skipper D.S and Witherspoon R.L. 1979. Good schools for young children Macmillan Publishing Co., Inc. New York.
9. Morrison GS. 1998. Early childhood education today. 7th edition, Merril, an imprint of Prentice Hall, Upper Saddle River, New Jersey Columbus, Ohio.
10. Robert V. and Kail. 2019. Children and their Development Pearson India Education Services Pvt. Ltd, Uttar Pradesh, India.
11. Sararwathi, T. S., Menon Shailaja and Madan Ankur. 2021. Childhood in India. Routledge Toylr and Francis Group New York
12. Swaminath Mina and Daniel Prema. 2019. Play Activities for Child developmentNational Book Trust, India

Module on
Communication Technology and Journalism - I

Print Journalism **1 (0+1)**

Objectives

1. To equip with necessary knowledge about various print journalism
2. To impart skills in development and use of various print media
3. To develop comprehensive skill in writing and editing of an article

Practical

Identification and discussion on various types of print material, Planning and production of news - news gathering by using direct and indirect methods, news gathering by using interview techniques, different forms of news reports and writing news- curtain raiser, spot news/live report, investigative report/interpretative, in-depth report/advocacy report, cultural events, civil and social events reporting, crime and sports reporting, specialized reporting – environment and ecology, agriculture, health/nutrition issues, women and children issues, human interest stories, travelogues, humor writing and types of column writing, Editing of news. Planning for article writing and its production. Editing of article-rewriting, integrating, updating, referencing and proof reading. Planning for feature writing and its production. Editing of feature. Planning, production and editing of advertisements. Exposure visits and hands on experience on printing technology, visit to University press to understand the production process and equipment.

Suggested Readings

1. Ajay D. Basic concepts of journalism.
2. Ahuja, B.N. and Chabra S. S. Principles and Techniques of Journalism.
3. Bhatnagar, R. 2001. Print Media and Broadcast Journalism. Indian Publisher Distributors, New Delhi.
4. Bisht, M.S. 2007. Journalism techniques and practices. first edition, cybertech publications: New Delhi.
5. Kamath M.V. The journalist's handbook.
6. Rangaswami, P. 1984. Basic journalism.

Electronic Journalism 1 (0+1)

Objectives

1. To equip with necessary knowledge about various electronic media
2. To impart skills in development and usage of various electronic media formats
3. To impart skill in planning and developing of script
4. To develop skills in production technology of TV and radio programs

Practical

Visit to radio station, Doordarshan/local television channel, Formats of Radio Programs – features, discussions, news bulletins, drama, talk, Writing and editing script for radio program, Rehearsal, recording and editing with computer-based editing software and presentation for radio script, Application of photographic principles, Formats of Television Programs, Screening and TV cultural news programs, Screening of TV political and sports news programs, Screening of developmental TV programs, Video script -basic production script, Different types of video scripts – storyboard script, Planning script for video program – 1 minute program, Writing and editing script for program, Script writing for documentary and drama, Script writing for educational program, Planning script for advertisements – storyboard, Practice news reading, Anchoring for radio program, Presenting Radio and TV news, Rehearsal, recording and editing with computer-based editing software and presentation.

Suggested Readings

1. Bhatt, S.C. Broad cast journalism, basic principles. Har Anand Publisher, Delhi.
2. Millerson, G. and Owens, J. (2008). A Handbook of video production, Butterworth-Heinemann, oxford.
3. Millerson, G. and Owens, J. (2008). Television production. Focal Press London.
4. Hedgecoe, J. (1997). The Photographer's Handbook: A complete reference manual of photographic techniques, procedures and equipment.
5. Kimberly A. Neuendorf. (2019). The Content Analysis Guidebook. Online Publication. DOI: https://dx.doi.org/10.4135/9781071802878
6. Pray, G. L. (2004). Communication and Management. Kalyani Publishers, New Delhi.
7. Sandhu, A.S. (1993). Textbook on Agricultural Communication: Process and Methods. Oxford and IBH Publishing Pvt. Ltd., New Delhi.
8. Waters, A. (2018).Confident Digital Content : master the fundamentals of online video, design, writing and social media to surcharge your career https://books.google.co.in/books/about/Confident_Digital_Content.html.

Semester IV

Institutional Food Service Management 3 (2+1)

Objectives

1. To enable them in planning, execution and control of the management of institutes with ease and profit

2. To provide practical knowledge about keeping inventory of stocks, tool management and cost calculation
3. To Proclaim work study, work simplification and its improvement in day to day life

Theory

Introduction- Classification of food service institutions, Function, Profit oriented, public health facility oriented. Processing method- Conventional system, fast food service systems. Service of food- Self-service, tray service, waiter-waitress service, Floor planning and layout. Characteristics of typical food service facilities. Floor planning and layout for catering establishment. Catering Equipment- Introduction, Classification, Factors involved in selection of equipment, Factor involved in purchasing of equipment, Use and care of major equipment. Food preparation- Introduction, Principles of food preparation, Characteristics of food, Principles of food purchasing, Methods of food purchasing, Storages of foods. Menu planning- Definition of menu planning, Principles of menu planning, Types of menus. Standardization of recipe- Definition of standardization of recipe. Standard portion sizes, Portioning equipment, Portion control, Use of left over foods. Management- Definition Principles of management, Steps in effective management, Techniques of effective management Tools of management. Organization chart, Work study, Work simplification, Work improvement financial management. Introduction, Principles, Costing, Budgeting, Accounting, Food cost control methods. Factors affecting food cost, labor cost, operating cost and overhead cost. Personal management Introduction, Personal management concepts, Staff employment, Employee benefit, Methods of selection, Orientation, Training and development, Supervision, Motivation of employees.

Practical

Standardization of at least 2 recipes in each of the following category: cereal and cereal products vegetables Fruits. Meat, Chicken and other fleshy foods, Sugar and Jaggery, Milk and its products. Pulses, Nuts and Oil seeds, sweet and savory dishes, snacks, traditional recipes. Planning and preparation of menu for various occasions and to calculate amount of each food ingredients: Birth day menu, Holy function menu, New year special menu, wedding menu, Lhori special menu, Christmas special menu. Calculate food cost labor cost operating cost and overhead cost of a home-made dish Calculate gross profit percentage of establishment welfare/ commercial / transport catering. Calculate break-even point any establishment welfare/ commercial / transport catering. Table setting, Maintenance of accounts and record keeping. Visit to various food service institutions and observation of physical facilities menu cards serving style table setting number of personnel and their work schedule hygiene and sanitary conditions safety measures etc. Report writing and presentation.

Suggested Readings

1. Arora RS (2012) Banquet and Catering Management. Abhijeet Publications.
2. Beckley JH, Herzog LJ and Foley MM (2017) Accelerating New Food Product Design and Development. 2nd Edition, John Wiley and Sons Inc. Hoboken, New Jersey.
3. Bhajwani Mudit (2007) Food Service Management: Principles and Practice. Rajat publications, New Delhi.
4. Bhat Harish (2008) Hotel Management. Crescent Publishing Corporation.

5. Carpenter RP, Lyon DH and Hasdell TA (2002) Guidelines for Sensory Analysis in Food Product Development and Quality Control. 2nd edn, Aspen Publishers Inc. New York.
6. Earle M and Earle RL (2008) Case Studies in Food Product Development. Woodhead Publishing Limited and CRC Press, New York.
7. Moskowitz HR, Straus T and Saguy S (2009) An Integrated Approach to New Food Products Development. CRC Press, Boca Raton, Florida.
8. Nancy LS (2007) Catering Management. John Wiley and Sons.
9. Puckett RP (2012) Good Service Manual for Health Care Institutions. 4th Edition, John Wiley and Sons Inc. Hoboken, New Jersey.
10. Sethi M (2018) Catering Management- An Integral Approach. 3rd Edition, New Age International, New Delhi.
11. Vaclavik V (2018) Dimensions of Food. CRC Press.
12. https://www.ferrerofoodsservice.com
13. https://www.foodservicedirector.com

Retailing and Merchandizing 2 (1+1)

Objectives

1. To learn about retailing and various formats of retailing
2. To understand the organizational structure of the retail firms
3. To know about the merchandising division in an apparel firm
4. To gain knowledge of the sales promotion techniques used in the industry
5. To become familiar with the export and import procedures and organizations in export promotion

Theory

Retailing - Introduction to textile and apparel industry, nature, scope, importance of retailing and merchandising. Retailing concept and principles, retail life cycle, market segmentation, key players at domestic, national and global level. Retailing and merchandising in India – status, evolution and trends. Classification of retail formats – store or onsite retailers, non store or off-site retailers, e-tailing and online/virtual sales and promotions. Organizational set up- on site retailers and off-site retailers. Merchandising – concepts, terminology of merchandising, factors affecting buying function, merchandising plan, buying plan, fashion calendar and merchandising planner. Merchandising –functions of buying for store, chain store, buying house, studios, export houses, catalogue sales. Merchandising – categories, textile, apparel and fashion merchandising, retail merchandising. Roles and responsibilities of merchandiser, merchandising team. Factors affecting Merchandising-Franchising, trade promotions, supply chain management, logistics management, physical distribution. Sales promotion techniques, fashion advertising and promotion – media, trends and methods. Visual merchandising – introduction, functions, elements, interior display, exterior display, planogram, trends, mall designing and visual display planning for commercial spaces. Export and import procedure in India; primary and ancillary documents. Export Promotion Councils and their roles.

Practical

Introduction to retail markets. Developing questionnaire and survey to assess the retail / wholesale scenario in Apparel and textiles. Analysis of textile and apparel market -visit to wholesale sectors. Analysis of textile and apparel market -visit to retail and exclusive showrooms. Analysis of textile and apparel market -visit to chain stores and reporting. Analysis of textile and apparel market -visit to factory outlets. Analysis of textile and apparel market -value addition techniques and products. Analysis of textile and apparel market reports in view of selected product category for business development. Developing and presentation of the visual display techniques –textiles / apparel. Planning promotion techniques for textile, apparel and fashion items. (Design and Product development, textile and apparel categories, fashion direction, Forecasting, Product Specification, Sample/ Prototype Development, range planning, product assortment and their significance in product planning, pricing of the products) * Textile, apparel and fashion promotion event planning and organization. Introduction to retail markets. Developing questionnaire and survey to assess the retail /wholesale market scenario in Apparel and Textiles. Analysis of textile and apparel market -visit to wholesale / retail and exclusive showrooms/ factory outlets/ chain stores and reporting. Analysis of textile and apparel market reports in view of selected product category for business development. Developing and presentation of the visual display for textiles /apparel retail outlet. Planning promotion techniques for textile or apparel / fashion items in a retail outlet*. Textile or apparel / fashion promotion event planning and organization (Design and Product development, textile and apparel categories, fashion direction, Product Specification, Range planning, product assortment and pricing of the products).

**Can utilize the products developed in other courses also.*

Suggested Readings

1. Berman Barry (1983) Retail Management-A Strategic Approach, Macmillan, NY.
2. Bell J (2006) Silent Selling, 3rd edn, Fairchild Publications, NY.
3. Bellenger D N and Goldstucker J L (1983) Retailing Basics, Richard D. Irwin Inc.
4. Bickle C (2005) Fashion Marketing – Theory, Principles and Practice Marianne Fairchild Publications, NY.
5. Diamond E (2006) Fashion retailing, Pearson publications.
6. Donnellan John (2013) Merchandise Buying and Management, A and C Black.
7. Easey Mike (2000) Fashion Marketing, Second Edition, Blackwell Publications.
8. Fiore A M and Kinkle P A (1997) Understanding aesthetics for the merchandising and design professional, Fairchild Publications, NY.
9. Gini S Frings (1998) Fashion from concept to consumer, Prentice Hall, USA.
10. Jackson T and Shaw D (2001) Mastering fashion buying and merchandising management-Palgrave publication.
11. Kincade D H and Gibson (2012) Merchandising of Fashion Products. Pearson Education.
12. Kumar M K (2010) Apparel Merchandising, Abhishek Publications.
13. Poloian L G (2003) Retailing Principles – A Global Outlook, Fairchild Publications.
14. Pradhan S (2008) Retailing and Merchandising – text and cases, Mc Graw Hill Publications.

15. Rabolt N and Miller J (2008) Concepts and cases in Retail and Merchandise Management, Mc Graw Hill Publications.
16. Rabolt N J (2009) Retailing and Merchandising Management, Mc Graw Hill Co.
17. Rosenau J A and Wilson D L (2006) Apparel Merchandising – the line starts here, 2nd edn, Fairchild Publications, NY.
18. Sheshadri M.S. -Apparel Marketing and Merchandising, First edition, M.S. Publications.
19. Stone E (1985) Fashion Merchandising, 4th edn, Mc Graw Hill Co. NY, USA.
20. Stone E (2007) Fashion, Fairchild Publications, NY.
21. Stone E (2007) In Fashion – Fun, Fame, Fortune, Fairchild Publications, NY.
22. http://ecoursesonline.iasri.res.in/course/view.php?id=233
23. e-Book on Research Methodology by C.K. Kothari (2021 Ed)
24. e-Book on Retail recovery by Mark Piginton
25. https://bookauthority.org/book/Retail-Recovery/1472987179
26. e-Book on The Effects of E-Commerce on Retail Supply Chains
27. By Steven Humphrey (2021 Ed)
28. https://bookauthority.org/book/The-Effects-of-E-Commerce-on-Retail-Supply-Chains/B098CWD6JB
29. e-Book on An Introduction to Fashion Retailing From Managing to Merchandising by Dimitri Koumbis (2021 Ed)
30. https://bookauthority.org/book/An-Introduction-to-Fashion-Retailing/1350098272

Housing and Space Management 3 (1+2)

Objectives

By the end of the course, the student must be able to:

1. Recognize a family's needs in relation to housing and gain knowledge on housing issues and building services.
2. Gain practical knowledge in designing space for different family needs
3. Learn the basics of architectural symbols and plans
4. Learn about the efficient arrangement of space in interiors
5. Learn to develop the house plans including furniture

Theory

Housing – importance, characteristics and effects of insufficient housing - Housing needs at different stages of family life cycle - Housing problems in India - rural and urban housing: Housing legislation and regulations in India - Building Codes, Floor Space Index (FSI/FAR): Factors to be considered in the selection of family housing, selection of site - Advantages and disadvantages of renting and owning a house - Types of house plans - floor plan, site plan, cross sectional plan, perspective plan, elevation plan and landscape plan; Principles of house planning: orientation and aspect, privacy, grouping, roominess, prospect, flexibility, circulation, sanitation, furniture requirement and practical considerations - Space management based on functional areas

- Space management and Interior types based on functional needs - interiors for youth/ elderly / other special needs - Building Services-Electrical layout and wiring, Plumbing and sanitation - Construction Techniques for safety- damp proofing, fire proofing, termite Proofing, sound proofing, security features - Housing standards -Technology in housing - advanced technology in housing construction/ Low cost building technologies, low cost building materials

Practical

Learning and comprehending architectural symbols; Lettering design and techniques - Planning Space arrangement for different room / areas in the home - Different types of Kitchens - Designing for special needs - Planning Space saving storage solutions for various rooms / uses - Drawing of House plans - EWS, LIG, MIG, HIG, Rural; Plans, electrical wiring and fixtures, plumbing and water supply - House plan for renovation according to needs of residents - Market survey to study the available building materials in the local market.

Suggested Readings

1. Agan Tessie, The House: Its Plan and Use. Oxford and IBH Publishing Co., New Delhi.
2. Agarwala S C (2008) Architecture and Town Planning, Dhanpat Rai and Co, N. Delhi
3. Arora and Bindra, Building Construction
4. Cherunilam F and Heggade O (1987) Housing in India. Mumbai: Himalaya Publishing.
5. Dorothy Stepat - Devan, Kathryn Camp Logan, Darlene M. Kness, Laura Szekely. Macmillan Publishing Co., Inc, New York.
6. Dutt D R, How best to plan and build your home, Pustak Mahal, Delhi
7. Faulkner R and Faulkner S (1975) Inside Today's Home. New York: Rinehart and Winston.
8. Mathur G C (1993) Low Cost Housing in Developing Countries. New Delhi: Mohan Primlani, Oxford and IBH.
9. Punmia B C (1993) Building Construction, Laxmi Publications, N. Delhi.

Theories and Practices in Early Childhood Education 2 (2+0)

Objectives

1. To understand the various theories of Early Childhood Education
2. To learn scientific practices in Early Childhood Education

Theory

Importance of theoretical perspectives in early childhood care and education – Early childhood education practices ; Play – based, Montessori, Waldorf, Reggio- Emilia, Religious schools, High Scope, Direct instruction, Bank street approach - Attachment theory of Bowlby and Ainsworth - Ecological systems theory of Bronfenbrenner - Theories of Learning- classical conditioning, Operant conditioning of Skinner, Trial and Error learning by Thorndyke; Social learning theory of Bandura - Cognitive theory of Maria Montessori, cognitive development theory Jean Piaget, socio- cultural theory of Lev Vygotsky, multiple intelligences theory of Howard Gardner – Erickson's Psycho Social development theory- disciplining children theories; parenting styles, Hoffman's disciplinary techniques - Application of theories in classroom - Challenging aspects of practice of theories in early childhood care and education.

Suggested Readings

1. Soni R (2015). Theme Based Early Childhood Care and Education Programme– A Resource Book. NCERT, New Delhi.
2. Wiltshire M (2010). Understanding the High Scope Approach, Early Years Education in Practice. Taylor and Francis.
3. Deiner P L (2006). Inclusive Early Childhood Education. Cengage Learning Press.
4. Kaul V (1997). Early Childhood Education Programmes. NCERT, Delhi.
5. Roopnarian Jaipaul I and James E J (2008). Approaches to Early Childhood Education. Pearson Education, Atlantic.

Training and Professional Development 2 (0+2)

Objectives

1. To impart basic knowledge on types and techniques of training for professional development
2. To develop the skill on designing and conducting a training program
3. To develop an understanding of the various techniques like team building, group discussion and brain storming for professional development

Practical

Learning Theories-Basic concepts of learning theories. Principles of learning, learning patterns, characteristics of learning process. Theories of learning- Behaviorism, Cognitivism, Social learning theory, Social constructivism, Multiple intelligences, Brain-based learning. Purpose of learning theories in training and professional development. Advantages and limitations. Interaction with trainees and training officials and find out the method and apply the same for professionals. Training Approach-Basic concept of training approach. Purpose of training approach.

Types of training approach. Steps involved in training approach. Advantages and limitations. Preparation of training, content and procedures (methods and materials). Types of Training-Meaning of training for professional development. Purpose of training for professional development. Pre-service training. In service training and staff development. Evaluation and assessment of training. Detect and predict defects in the procedural design of a training activities.

Phases of Training- Planning Phase –Setting the goals and objectives of an organization, analyzing –the human resources, efficiency indices and organizational climate. Implementation Phase –publicity, develop training brochures, annual calendar of learning opportunities, time about their teaching plans. Evaluation Phase - reaction, behavior and result. Types of Evaluation – evaluation for planning, process of evaluation, terminal evaluation and impact evaluation. Key elements of the training activities are systematically monitored, problems are to be identified and attempts are to be made to rectify.

Designing training program - Gain attention, inform learner and objectives, stimulate recall of prior learning, Present stimulus material, provide learner guidance, elicit performance, provide feedback, assess performance, enhance retention transfer, interact with trainers and learn the practical requirements

Suggested Readings

1. Bahal, R., Swanson, B.E., and Farner, B.J. (1992). Human resources in agricultural extension: A worldwide analysis Indian Journal of Extension Education
2. Bhattacharyya, Dipak Kumar. (2015). Training and Development. New Delhi: Sage Publication Limited.
3. Dahama, O.P. (1979). Extension and rural welfare New Delhi: Ram Parsad and Sons
4. Elam, S. (1971). Performance based teacher education: What is the state of the art Washington. DC: AACTE.
5. Flippo, E B. (1961). Principles of personnel management. New York: McGraw Hill
6. Kirkpatrick, D. (1976). Training and Development Handbook. New York: McGraw Hill
7. Lynton, R.P. and Pareek, U. (1990). Training for development. West Hartford, CT: Kumarian Press.
8. McGhee, W. and Thayer, P. W. (1961). Training in business and industry. New York: John Wiley and Sons.

Agricultural Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and

hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

Skill Enhancement courses (SEC-IV Modules) 2 (0+2)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-Diploma, they can work with food preservation units, fashion design units, portfolio development studios, interior design /decoration units/shops, furnishing houses, ECCD centres, audio recording/video making studios, etc. or can go for self-employment.

Indicative options for SEC-IV module *(any one module to be selected)*

Module	Course	Credit Hours
Food Service Management - II	Food Preservation and Storage-I	1 (0+1)
	Food Preservation and Storage-II	1 (0+1)
Fashion Designing- II	Fashion Illustration	1 (0+1)
	Portfolio Development	1 (0+1)
Interior Design and Decoration - II	Interior Accessories and Furnishings	1 (0+1)
	Interior designing and decoration II	1 (0+1)
Early Childhood Care and Education - II	Management of ECCE centre	1 (0+1)
	Monitoring and evaluation of ECCE centre	1 (0+1)
Communication Technology and Journalism - II	Audio and Video Recording	1 (0+1)
	Instructional Video Production	1 (0+1)

Module on
Food Service Management - II

Food Preservation and Storage –I 1 (0+1)

Objectives

1. To learn different methods of preservation and storage of various foods
2. To know the factors affecting shelf life of preserved foods

Practical

Market survey of raw and preserved foods. Selection, purchase and storage of perishable, non -perishable and semi perishable foods for preservation. Preservation by bacteriostatic methods - drying, dehydration, use of high temperature, Sterilization, blanching, pasteurization, canning, ultra-heating, Preparation of products cereals and starches: Papads: wheat, maize or other cereal

grain, sago papad and other regional preparations. Fryums, rolls and other snack items. Preservation of products using pulses: Papads: mung dal, chana dal, urad dalor other pulses, badi, mungodi etc. andother regional preparation. Drying of fruits and vegetables: Leafy vegetables: spinach, fenugreek leaves, coriander, bathua, Other vegetables: peas, beans, tomatoes, lady fingers, cluster beans, bitter gourd etc., Roots and tubers: potato chips, onion flakes. Fruits: ber, grapes, raw mangoes, banana powder. Sterilization, bottling, corking, blanching. Preparation of products using natural preservatives: Sugar. Squashes - Lemon, orange, grapes, guava, custard apple, amla, ber, jamun, mix fruits etc. Sugar syrups: Lemon, orange, grapes, guava, rose, kewda etc. with use of low temperature, chilling, freezing, other recent methods in preservation. Preparation of products using natural preservatives Sugar –Squash, Cordial, Syrups, candies, Jam, Jellies, Preserves Murabba, Oil and Salt, Vinegar - pickles with and without oil, Chutneys, other chemical preservatives – Sauces, purees. Storage of perishable, semi perishable and non -perishable foods. Antimicrobial agents, Biological agents, nonionizing and ionizing radiations in preservation of foods. Hurdle technology. Packaging and packaging material, Labelling and costing of the products. Visit of storage go downs –FCI and others.

Suggested Readings

1. Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
2. Kalia, M. and Sood, S. (2010). Food Preservation and Processing.Revised Edition, Kalyani Publishers, New Delhi.
3. Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
5. Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.
6. Vijay K. (1999). Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.

Food Preservation and Storage -II 1 (0+1)

Objectives

1. To learn the techniques of preservation and storage of fruit and vegetables
2. To learn the prevention of contamination of food from damaging agents

Practical

Preparation of Jam, Jellies, Preserves, Murabba, Candies, Marmalades, Preservation by using Oil, Salt and Vinegar, Pickles with and without oil – Mango, amla, lemon, green chilli, mix vegetables, fresh turmeric, garlic, gonda, carrot. Pickles using other chemical preservatives – Chutneys, purees. Fermented pickles. Ketchups and sauces. Freezing of fruits and vegetables, Concentration of fruit juices. Hurdle technology. Use of anti -microbial agents, food additives and preservatives. Methods of storing preserved foods, prevention of food spoilage. Packaging and packaging material. Labeling and costing of the product. Demonstration on bottling, pasteurization, canning, ultra- heating. Demonstration on ionizing and non- ionizing Irradiation in foods, ohmic heating. Visit to food processing plant.

Suggested Readings

1. Jay, J.M. and Vannost, D. (2005). Modern food microbiology, 7th edn.
2. Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
3. Kalia, M. and Sood, S. (2010). Food Preservation and Processing.Revised Edition, Kalyani Publishers, New Delhi.
4. Kyzlink, V. (2003). Principal of food preservation, 2nd edn, Esevier press.
5. Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
6. Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
7. Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.
8. Vijay K. (1999). Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.

Module on Fashion Designing - II

Fashion Illustration 1 (0+1)

Objectives

To gain knowledge on fashion illustration and development of design studio

Practical

Human Body and body proportion theory. Preparation of fashion figure. Drawing 10 and 12 headed fashion figure using geometric body shape. Figures in different poses. Drawing of facial features- eyes, nose and lips. Proportion of body parts- head, face, hand and feet according to different age group. Sketching figures of different age group based on head theory. Sketching of garment features minimum three: collars, neckline, fasteners, sleeves, pockets, cuffs and hemline.

Sketching of added fullness: frills, flounce, gather and pleats. Sketching of accessories: hats, shoes, boots, belts and purses. Designing of garments for adult and child -Male and Female. Illustration of fabric design and texture using different media -water colour, pencil colour, collage, poster colour and crayon colour. Theme based Portfolio development through CAD.

Suggested Readings

1. Allen and Seaman. 1994. Fashion drawing- The Basic Principles, B. T Batsford, London.
2. Berthoud, F. 2011. Francois Berthoud Studio: The Art of Fashion Illustration Hatje Cantz; Bilingual edition, ISBN-10: 9783775730143.
3. Bina, A. 2012. Fashion Sketchbook. 4th edn. New York. Fairchild books.
4. Brambatt, M. 2017. Fashion Illustration and Design: Methods and Techniques for Achieving Professional Results, Promopress publishing, ISBN-10:8416851069, ISBN-13: 978-8416851065.
5. Hart, C. 2013. Fashion Design Studio: Learn to Draw Figures, Fashion, Hairstyles and More (Creative Girls Draw), Sterling; Illustrated edition, ISBN-10: 1936096625.
6. Ireland, P.J. 1970.Fashion Design Drawing. London. B.T. Batsford Ltd.
7. Ireland, P.J. 1980. Basic Fashion Design. London. B.T. Batsford Ltd.

8. Ireland, P.J. 1974. Fashion Drawing for Advertising. London. B.T. Batsford Ltd.
9. Kathryn, K.C. and Munslow, J. 1997. Illustrating Fashion. Oxford. Blackwell Science.
10. Kiper, A. 2011. Fashion Illustration: Inspiration and Technique, David and Charles publishing, ISBN-10: 0715336185, ISBN-13: 978-0715336182.
11. Riegelman, N. 2009. 9 heads: A guide to drawing fashion. Boston. Pearson education.

Portfolio Development **1 (0+1)**

Objectives

1. To impart practical skills for developing theme based portfolio
2. To make students understand the importance and significance of Portfolio Development through CAD

Practical

Introduction to CAD, Different advanced software used in fashion industry, Portfolio preparation- Definition, types and importance, Contents of portfolio, Different portfolio presentation, skills and material management, Experimenting and creating a story board, steps to do forecasting, Mood board, client board and colour board, swatch board, Illustrations and Flat sketches, Production of Spec sheet and costing, Development of Logo, Hang tags, Concept board. Role of fashion illustrator and career opportunities, Theme based Portfolio development through CAD.

Suggested Readings

1. Barrett, J. C. (2012) Designing Your Fashion Portfolio: From Concept to Presentation, Bloomsbury Publishing India Private Limited; Nil edition, ISBN-10 : 1609010078, ISBN-13 : 978-1609010072.
2. Drake and Ireland, Patrick John. (1996). Fashion Design Drawing and Presentation, B. T, Batsford, London
3. Greenwood, M. and Murphy, M.F. (1978) Fashion Innovation and Marketing. New York, Macmillan Publishing Company.
4. Hart, C. (2013) Fashion Design Studio: Learn to Draw Figures, Fashion, Hairstyles and More (Creative Girls Draw), Sterling; Illustrated edition, ISBN-10 : 1936096625
5. Stone, E. and Sample, J.A. (1985) Fashion merchandising- An Introduction. IV Ed., New York, MacGraw-Hill Book Company.
6. Tate, S.L. and Edwards, M.S. (2006) Inside Fashion Design. Pearson Education India, ISBN-10 : 8131706958.

Module on Interior Design and Decoration – II

Interior Accessories and Furnishings **1 (0+1)Objectives**

By the end of the course, the student must be able to:

1. Identify different types of accessories and furnishings used in interiors, along with their use and features

2. Design and develop furnishings for different areas in the interiors
3. Design and develop accessories used for decorating interiors
4. Understand how accessory and furnishing designing can be taken up as an entrepreneurial activity

Practical

Identifying different accessories, their use, placement, and features - Market Survey to study the design features and financial aspects of different interior accessories - Understanding the application of art elements and design principles for designing accessories - Exploring and selecting different art media for designing and developing a functional/ decorative accessory: mud/ clay/ paper/ glass/ fabric/ wood/ MDF/ painting/ printing - Designing and preparation of accessories suitable for different types of staircases, table decoration, floor decoration - Interior landscaping: Exploring its importance and different plants used in interiors - Applying Vastu Shastra in selection and placement of accessories - Identifying different furnishings, their use, placement, suitable materials and features- Market Survey to study the design features and financial aspects of different interior furnishings - Understanding the application of art elements and design principles for designing furnishings for residential and commercial spaces -Exploring Indian handicrafts, paintings, embroideries, printing techniques etc. and application of feasible techniques in designing accessories and furnishings - Cost estimation, Sale of products and Self - evaluation.

Suggested Readings

1. Chopra Tarun. 2006. Exotic Indian Interiors. Prakash Books India Pvt. Ltd, New Delhi, India.
2. Gates Erin T. 2014. Elements of Style: Designing a Home and a Life. Simon and Schuster, New York, USA.
3. Jaity Jaya. 2012. Crafts Atlas of India: Special Edition. Niyogi books, New Delhi, India.
4. Massey Anne. 2020. Interior Design Since 1900: 4th edn. Thames and Hudson, London, UK.
5. Wilson Henry. 2001. India: Decoration - Interior - Design. Watson-Guptill Publishers, New York, USA.

Interior Design and Decoration II 1 (0+1)Objectives

By the end of the course, the student must be able to:

1. To understand the concept of wall and floor treatment
2. To understand basic principles of acoustical insulation to interior spaces
3. To impart knowledge on working and managing of interior design as professional practice

Practical

Application of elements and of principles of design; colour concept: colour schemes and its cost estimation, colour scheme for problematic area; curtains and draperies, types of curtain material and hardware's, and it's costing; lighting, types of light fixture, use of lights and lamps, lighting plan for problematic area; floor treatments and its type; wall treatment and its types; accessories for interiors; materials used for interior designing and decoration; indoor landscaping; flower arrangements; Auto CAD for interiors; visit to any residential and commercial building to study about materials used for interior designing and decoration.

Suggested Readings

1. Ch'ing, Francis D K, Binggeli, Cork. 2004. Interior Design Illustrated. Wiley Publications, New Jersey.
2. Claffey Bree. 2017. Indoor Green: Living with Plants. 1st edn. Thames and Hudson.
3. Cremer Lothar. 2016. Principles and Application of Room Acoustics. Peninsula Publishing.
4. Drpic Ivo D. 1988.Sketching and Rendering of Interior Space. Watson – Guptill.
5. Dechiara Joseph, Panero Julius and Zelnik Martin. 2011.Time Saver Standards for Interior design and Space Planning. McGraw Hill, London.
6. Dechiara Joseph and Panero Julius. 2011. Standards for Interior Design and Space Planning. McGraw Hill Professional.
7. Faulkner S and Faulkner R N. 1968. Inside Today's Home. Holt, Rinehart and amp; Winston.
8. Maureen Mitton and Courtney Nystuen. 2016. Residential Interior Design - A Guide to Planning Spaces. 3rd edn. Wiley Publication.
9. Keeping Miles and Shiers David. 2017.Sustainable Building Design: Principles and Practice. 1st edn. Wiley Blackwell.
10. Piotrowski Christine M. 2016. Designing Commercial Interiors. 3rdedn. John Willey Publishers.
11. Pratap R M. 2012. Interior Design Principles and Practice. Standard Publications, Delhi.
12. Seetharam P and Pannu P. 2009. Interior Design and Decoration. 1st edn, CBS, New Delhi

Module on
Early Childhood Care and Education – II

Management of ECCE Centres — 1 (0+1)Objectives

1. To gain practical experience in monitoring the different early childhood care and education centres
2. To develop skills for management of early childhood care and education program
3. To provide practical experience in monitoring an early childhood education centre in urban and rural areas

Practical

Principles of management – Theories of management ; benefits of using management theories- the seven theories; Scientific management theory, principles of administrative management theory, bureaucratic management theory, human relations theory, systems management theory, contingency management theory and theory of X (authoritarian) and Y (participative) – Motivation ; Maslow's theory, McClleland theory, McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory - Goal setting; Locke and Latham Goal setting principles, essential elements in goal setting - Framing administrative policies for ECCE center: elements in administrative policies. Conducting mock interviews for selection of various staff members, and framing criteria for their selection - Budget provisions for various ECCE centres - short term and long budget term planning, cost of operation, expenditure on equipment, salaries and other benefits to staff, maintenance of daily, weekly and monthly accounts - Preparing a plan to meet emergencies.

Suggested Readings

1. Brophy J E, Good T I and Nedler S E (1975) Teaching in the preschool. Harper Row publisher, New York.
2. Day B (1983) Early Childhood Education: Creative learning activities Macmillan Publishing Co., Inc. New York
3. Evans B E, Shurb B and Weinsten M (1971) Day care. Beacon Press, New York.
4. Frost J Lan and Kissinger J B (1976) The young child and the educative process. Holt, Rinechort and Winston, New York
5. Grewal J S (1984) Early childhood education: Foundations and practice. National Psychological Corporation, Agra.
6. Kuppuswamy B (1990) Child behaviour and development. Konark Publishers Pvt. Ltd. New Delhi.
7. Leeper S H, Skipper D S and Witherspoon R L (1979) Good schools for young children Macmillan Publishing Co., Inc. New York.
8. Morrison G S (1998) Early childhood education today. 7th edition, Merril, an imprint of Prentice Hall, Upper Saddle River, New Jersey Columbus, Ohio.
9. Murlidharan R and Banerji V (1991) A guide for nursery school teachers, National Council of Educational Research and Training, New Delhi.
10. Mohanty J and Mohanty B (2007) Early childhood care and education. Deep and Deep Publications Pvt. Ltd., New Delhi.
11. Sinha A (2005) manual of early childhood education Print Palace, Agra.
12. Taraporevala R and Chhugani N (2002) Early childhood years- Handbook for parents and teachers. English Edition Publishers, Mumbai.
13. Singh B (1997) Pre school education. APH publishing Corporation, New Delhi.
14. Swaminathan M (1991) Play Activities for young children, P.S. press Service, Pvt. Ltd, New delhi.
15. Seefeldt C and Barbour N (1994) Early Childhood Education – An introduction Maxwell Macmillion, Canada.
16. Vashist Neeru and Vashist Vibhuthi - Principles of Management (other basic management textbooks).

Monitoring and Evaluation of ECCE Centres 1 (0+1)

Objectives

1. To learn to monitor the ECCE programme
2. To learn about the regulations of standards for Quality of ECCE centre

Practical

Concept of quality and minimum regulations in early childhood education - important factors to consider in quality; The four dimensions are: those of society, the child, the teacher and the learning context; four dimensions in quality assessment such as the society, the child, the teacher and the learning context. - Concept of evaluation and monitoring; defining the concepts; - monitoring

and evaluation of budget distribution for ECCE activities - monitoring admissions of children - monitoring and evaluation of lesson plans - monitoring and evaluation of classroom practices - monitoring and evaluation of children's assessment; monitoring and evaluation of staff supervision and performance; characteristics of ideal child care supervisors and teachers, their qualifications and training - monitoring and evaluation of adult and child spaces and their arrangements and utilization - monitoring and evaluation of service activities such as cleanliness, feeding, health care – monitoring, use and evaluation of teaching – learning equipment and material – monitoring and evaluation of record keeping- Awareness of national and international organisations working for ECCE.

Suggested Readings

1. Mohanty J and Mohanty B. 2000, Early Childhood Care and Education, Deep and Deep Publications Pvt. Ltd., New Delhi
2. Murlidharan R and Banerji V. 1969, A Guide for Nursery School Teachers, National Council of Education Research and Training, New Delhi.
3. NAEYC (National Association for the Education of Young Children). 2022, Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth Through Age 8. 4th edn. Washington, DC: NAEYC.
4. Roopnarine Jaipaul and Johnson James E. 2015, Approaches to Early Childhood Education, 5th edn, Pearson India.
5. Sue Dockett, Leonie Arthur, Sue Farmer, Bronwyn Beecher and Elizabeth Death. 2017, Programming and Planning in Early Childhood Settings**,** Cengage Australia.

Module on
Communication Technology and Journalism - II

Audio and Video Recording 1 (0+1)Objectives

1. To impart skills in handling video camera and camera support systems
2. To provide technical exposure to shooting
3. To build competency in planning, writing and shooting basic video production script, story board and camera script
4. To impart skill in audio and video recording, editing and mixing

Practical

Visit to NAARM /Electronic wing of University, Exposure to different types of cameras, Care and maintenance of cameras, Familiarization of video camera and parts of video camera, Familiarization with other accessories of video camera, changing and loading battery pack, Handling of camera support systems, Handling of video camera –home video camera and Practicing video camera with white balance, Handling compositions of video camera, handling of VHS camera and advanced professional cameras, Practical exercise on focusing, zooming and shooting, Planning of different camera positions - long shot, medium shot, close up, zoom, Tilting and panning, Lighting Techniques and moods, Familiarization of drone camera and its parts, Handling and operation of drone cameras, Practical exercise on different types of video scripts – basic production script, story board script, camera script, Planning script for video program - one minute program, Planning

script for documentary production and drama, Script writing for documentary and drama – storyboard, Shooting with different camera positions in outdoor- long shot, medium shot, close up and zoom, Shooting with different camera positions in Outdoor - tilting and panning, Exposure to audio recording equipment's, Handling of audio editing software, Sound - Audio recording and voice dubbing, Sound - Audio mixing, Presentation of produced program.

Suggested Readings

1. Wetzel Alan (1985) Television production McGraw-Hill Book Company New York S - New Delhi.
2. Glyn Arkin (1975) Television Sound Operation, Hunting house New York McGraw-Hill Book Company New York S -- New Delhi.
3. Herbert Zettle (2010) Video Basics, Wadsworth Publishing, Belmont, California.
4. John Eargle (1980) Sound Recording. Van Nostrand Reinhold Now.
5. Millerson Gerald and Owens Jim (2008) A Hand book of Video Production Butterworth-Heinemann, Oxford.
6. Millerson Gerald and Owens Jim (2009) Television Production, Focal Press, London.

Instructional Video Production 1 (0+1)

Objectives

1. To impart skills in handling video camera and camera support systems
2. To provide technical exposure to shooting
3. To build competency in mobile editing applications
4. To impart skill in linear and non-linear editing techniques
5. To get familiar with the video editing open-source software

Practical

Hands on experience of DSLR and video camera, Familiarization of open source software for video editing, Familiarization of open source software for audio editing, Video editing with using of smart phones (mobile) in mobile apps, Synchronization of audio in video editing smart phones (mobile), Familiarization of exporting final video output in mobile apps, Familiarization of creating videos using images and text, Designing of video titles with using adobe photoshop(text), Importing text titles from photoshop in video editing, Familiarization of voice recording techniques with using of smart phones (mobile), Practicing – installing of video and audio software into desktop computer, Practicing – installing of audio recording equipment with sound card, Advanced techniques of exporting of final video for different formats and sizes, Advanced video editing techniques – voice synchronization to video with using advanced software, Working with video libraries and graphics libraries, Recording techniques - video and audio online and offline editing, Recording techniques - video and audio linear editing and video and audio nonlinear editing, Editing of the recorded outdoor program by non-linear editing, Importing video - working methods of offline video editing, Advanced techniques of editing - cut. - mix with advanced software etc., Using graphics and animation in video production, Application of open-source software–gimp, blender, Open Broad Casting Software (OBS), google sketch up and any other, Presentation of produced program.

Suggested Readings

1. Television Production by Gerald Millerson
2. Editing Digital Video: The Complete Creative and Technical Guide (Digital Video and Audio) by Robert M. Goodman, Patrick McGrath
3. https://onlinecourses.swayam2.ac.in/ntr21_ed09/preview
4. Computer Graphics and Animation book pdf
5. http://cs.wellesley.edu/~cs110/lectures/M01-color/graphics.pdf
6. Learning Modern 3D Graphics Programming book pdf
7. https://www.docdroid.net/UKocmTz/arcsynthesis.pdf.html#page=194
8. Blender master class book pdf
9. http://dl.finebook.ir/book/9e/11032.pdf
10. A basic tutorial of Blender 3Dhttps://www.cs.auckland.ac.nz/~jli023/opengl/blender3dtutorial.htm
11. Camp Blender

http://web.engr.oregonstate.edu/~mjb/blender/blender.1pp.pdf

12. Using Sketch Ups

http://web.engr.oregonstate.edu/~mjb/sketchup/sketchup.1pp.pdf

Post-IV Semester

Internship (only for exit option for award of UG-Diploma) 10 (0+10)

Objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills for job interview process
5. Explore career alternatives prior to graduation

Activity

The students will have internship/ training for 10 weeks' duration either in the institute or in industry or related organisations. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester V

Human Physiology 3 (2+1)Objectives

1. To acquire knowledge about human physiology, structure of different system and mechanism of human body
2. To learn knowledge regarding organ system and Integration of the organ systems to maintain proper internal environment

Theory

Physiological process - Introduction. Structural basis of human body – cells and their functions. Structural basis of human body – tissues and their functions. Skeletal system. Joints. Muscular system- Function. Nervous system - Functions of brain. Functions of spinal cord. Nerve impulse reflexes. Physiology of digestion. Digestive enzymes and their functions. Functions of liver. Absorption from the intestine. Composition and functions of blood. Composition and functions of lymph. Structure of heart and course of blood circulation. Blood pressure and factors affecting blood pressure. Pulse rate and heart sounds. Intracellular and extracellular water compartment. Mechanism of respiration. Respiratory rates. Volume and transport of gases. Physiology of kidney. The location, secretions and function of various endocrine glands- pituitary, thyroid, parathyroid. The location, secretions and function of various endocrine glands – adrenal, testes, ovaries. The location, secretions and function of various endocrine glands –Pancreas, Placenta, pineal gland. Male reproductive organs and their functions. Female reproductive organs and their functions. Pregnancy, Changes in the mother. Fertilization, Development of foetus, Lactation.

Practical

Demonstration of animal viscera. Identification of systems and organs Identification of cells – epithelial Muscle, skeletal system, Nerves etc. Transverse section of stomach Intestine – small and large demonstration of specimens of spleen Kidney and brain models of excretory and reproductive organs. Estimation of RBC and WBC count by heamocytometer, Estimation of hemoglobin in mammalian blood, estimation of bleeding and clotting time and blood groups. Demonstration of differential counting of WBC using peripheral smear, T.L.C. and D.L.C. PCV ESR, micro and macro heamatocrit. Measurement of pulse rate and blood pressure Its variation with exercise, Heart beat and Heart sound. Testing for sensation Special sensors. Measurement of body temperature. Demonstration/Estimation Respiratory quotient Inspiration Expiration and measurement of O_2 and CO_2 at various partial pressure in lungs.

Suggested Readings

1. Best and Taylor. 1979. Physiological basis of medical practice. Tokyo, Igaku Shoin.
2. Chaterjee, C.C. 2012. Human Physiology. Vol. I and Vol. II. CBS Publications.
3. David, F., Stacia, B.M. and Charles, L.S. 1993. Human Physiology Foundations and Frontiers. 2nd edn, Mosby Pub.
4. Donnersberger, A. B. and Scott, A.L. 2005. Laboratory Textbook of Anatomy and Physiology. 8th edn, Jones and Bartlett Learning, Burlington, Massachusetts.
5. Ganong, E.F. 1995. Review of Medica Physiology. Norwalk: Simon and Schuster

6. Hall, J.E. 2016. Gaytonand Hall Text Book of Medical Physiology. 13th edn, Elsevier India.
7. Jain, A. K. 2009. Human Physiology for BD. 3rd edn, Avichal Publishing Company, New Delhi.
8. Marieb, E.N. 2004. Human Anatomy and Physiology. 6th edn. Pearson Education, Inc. London.
9. Waugh, A and Grant, A. 2014. Ross and Wilson Anatomy and Physiology in Health and Illness. 6th edn, Elsevier Ltd. Churchill Livingstone, London.

Food Hygiene and Sanitation 1 (1+0)

Objectives

1. To enable the students to know the significance of hygiene and sanitation in maintenance of health
2. To learn the importance of maintaining personal and food hygiene

Theory

Concept, significance and interrelationship of health, hygiene and sanitation. Principles of food hygiene. Food safety hazards: chemical, physical, effect of food composition. Beneficial and harmful microorganism in foods: an introduction. Food hygiene -Public health hazards due to contaminated foods. Food borne infections and intoxication, symptoms, sources and modes of transmission and method of prevention and control. Personal hygiene of food handler- Characteristics of good health and hygienic habits to promote good health. Toxins in foods: Naturally occurring, External. Effect of environmental pollution on food safety. Waste disposal. Water pollution, purification of water, quality criteria and standards of portable water.

Suggested Readings

1. Bedi, Y.P. 1970. A Handbook of Hygiene and Public Health. Atma Ram and Sons Publication, New Delhi.
2. Gibney, M.J., Margetts, B.M., Kearney, J.M. and Arab, L. (Eds) 2004. Public health Nutrition. The Nutrition Society Blackwell Science. Oxford.
3. Frazier, W.C. and West Hoff, D. C. 1988. 4th edn, Food Microbiology, Tata McGraw Hill Inc., New Delhi.
4. Jacob, M.1989. Safe Food Handling: A Training Guide for Managers of Food Service Establishment, WHO, Geneva.
5. Marriott, N. G. 1985. Principles of Food Sanitation AVI book, Van Nostrand Reinhold Publication, New York.
6. Park, K. 2000. Text book of Preventive and Social Medicine- A Treatise on Community Health 16th edn, M/S Banarasidas Bhanot Publication, Jabalpur.
7. Srivastava, A. 2013. Food hygiene and Sanitation. Neha Publishers and Distributers.

Techniques of Fabric Construction 3 (1+2)

Objectives

1. To acquire an understanding of loom and knitting machine
2. To develop skill in making different types of weaving and knitting
3. To acquaint with the various fabric construction methods

Theory

Introduction of different types of fabric construction techniques Woven fabrics - simple and compound woven structures, characteristics of woven fabric, History of weaving and looms; Classification of looms on the basis of mechanism, means of running loom, structure and means of weft insertion; Parts of loom, loom accessories and their functions (Mechanism of weaving: primary, secondary and tertiary motions); Basic weaves: Plain, twill, satin and their variations; Complex/ Fancy weaves: extra yarn fabrics, pile fabrics, leno weave, dobby and jacquard weave; Knitting: principle of knitting, types of knitting machines, their parts and functions; Knitting stitches: warp and weft knits, types of knit fabrics; Nonwoven Fabrics: Manufacturing process, characteristics and end uses.

Practical

Observation of fabric structures– Woven, knitted and nonwoven fabrics. Collection of fabric samples of different types of basic and fancy weave and their identification; Manual representation of woven design on graph sheet – plain weave, rib weave, basket weave, twill weave, satin and sateen weaves; Handloom and its parts; Observation of loom setting, weaving calculations and yarn preparation and making a plain weave sample on loom; Introduction and practice to various tools used in CAD weave software; Representation of basic weaves (plain, rib, basket, twill and satin) using textile design software; Hand knitting- two needle method, holding the needles and the yarn, casting on and knitting of plain ,rib and purl knit sample; Knots of macramé; Stitches of crochet; Manual felting; Visit to weavers service centre/textile industry for observation of weaving/knitting mechanism/finishing of fabrics.

Suggested Readings

1. Gokarneshan N (2020) Fabric Structure and Design. 3rd edn. New Age International (P) Ltd.
2. Hollen, N and Saddler J (1968) Textiles. New York Macmillan Company.
3. Joseph, M L (1986) Introductory Textile Science. 5th edn. New York CBS College Publishing.
4. John G (1999) World Textiles: A Visual Guide to Traditional Techniques. Thames Hudson publications.
5. Kadolph S J (2013) Textiles: Pearson New International Edition. Pearson Education Ltd, Asia.
6. Kaur N (2011) Fashion Concepts. Comdex: Fashion Design (Vol I). Dream Tech Press.
7. Labarthe J (1969) Textiles: Origins to Usage. New York. McMillan Company Ltd.
8. Potter M D and Corbman B P (1967) Textiles: Fiber to Fabric. New York. Macmillan Hill Co.
9. Vatsala R (2003) Textbook of Textiles and Clothing. New Delhi. Indian Council of Agriculture Research.
10. Wynne A (1997) Textiles the Motivate Series. Macmillan Hill Co.
11. https://www.textileblog.com/cad-cam-in-textile-and-garment-industry/
12. https://textilelearner.net/application-of-cad-in-textile/
13. https://www.slideshare.net/mjrtipu/different-software-use-for-textile-design
14. https://textilelearner.net/best-textile-design-software/

Principles of Textile Designing 3 (0+3)

Objectives

1. To impart knowledge about textile designs and process of applied designing
2. To inculcate ability to develop and arrange motifs into patterns for various articles

Practical

Introduction to textile designing (Basic process of textile designing), skills and qualities required in textile designer, Classification of textile designs and methods of producing designs on textiles: Structural designs through yarn manipulation, weaving, knitting and other techniques and Decorative designs through printing, dyeing, painting, finishing, embroidery and appliqué work. Elements of design: Line, shape, space, form and colour (Drawing various types of lines, shapes and forms, Colour: Colour wheel, value and intensity charts, related and contrasting colour schemes, Concept of positive and negative design space). Principles ofdesign: Balance, rhythm, proportion, emphasis and harmony (Proportion: Planning of basic shapes, scale of shapes and forms, division of space, creating optical illusion with lines and shapes, Balance: Creating formal and informal balance in design, Rhythm: Creating rhythm through repetition, progression, radiation and gradation of colour and pattern, Emphasis: Creating emphasis in design by the use of contrast of hue, value, line, shape and size and use of spacing around motif, Harmony: Harmony of line, shape, size, colour and texture in a design). Software for textile designing. Motif and its geometry (Motif as basic unit of design: selection of components of motif, motif development, symmetrical and asymmetrical motifs and their arrangements, Geometry involved in basic textile designing: translation, rotation, reflection and glide reflection, Pattern arrangements with motif in different repeats). Tools and menu of CAD software and its use for motif development. Development of patterns using different types of motifs (Developing geometrical/ abstract/stylized/naturalistic motifs and Pattern arrangements using different colour schemes to create variety in pattern). Use of CAD for pattern arrangement using different design repeat and colour schemes. Development of different types of border patterns. Preparation of swatch book: Fabric samples of different types of applied designs (dyed and printed fabrics).

Suggested Readings

1. Beitler, E. J. and Lockhart, B. 1961. Design for you. 2nd edn. New York: John Wiley and Sons, Inc.
2. Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh, India: Abhishek Publications.
3. Broomer, G.F. and Horn, G.F. 1977. Art in your world. Worcester, Massachusetts, Davis publications, Inc. 282p.
4. Evans, H. M. and Dumesnil, C. D. 1982. An Invitation to Design. New York: Macmillan Publishing Co. Inc.
5. Gahlot, M. and Naik, S.D. 2014. Principle of Design and Application. E-Home Science Courseware Consortium (NAIP).
6. Goldstein, H. and Goldstein, V. 1954. Art in everyday life. 4th edn. New York: Macmillan Publishing Co. Inc.

7. Graves, M. 1951. Art of Colour and design. 2nd edn, New York. McGraw- Hill Company.
8. Miller, J. 2003. The Style Sourcebook. London: Octopus Publishing.
9. Naik, S.D. and Wilson, J.A. 2006. Surface Designing of Textile Fabrics. New Delhi, New Age International (P) Limited Publishers. 120p.
10. Wilson, J. 2001. Handbook of Textile Design: Principles, Processes and Practice. CRC Press, Cambridge: Woodhead Publishing Limited.
11. Wilson, J. 2001. Handbook of Textile Design. Woodhead Publishing Series in Textiles.

E- References

1. https://nios.ac.in/media/documents/srsec321newE/321-E-Lesson-29B.pdf
2. https://www.mathsisfun.com/geometry/index.htmlhttps://coe.hawaii.edu/ethnomath/wp-content/uploads/sites/12/2019/10/Geometry-Translations-Rotation-Reflection-and-Dilations-in-Ethnic-Patterns-and-Designs.pdf
3. https://teachers.yale.edu/curriculum/viewer/initiative_10.04.09_u
4. https://en.wikipedia.org/wiki/Textile_design
5. https://www.emis.de/monographs/Isometrica/isometrica-2.pdf
6. https://condor.depaul.edu/ppereira/sym/Notes/Seven.pdfhttps://silo.tips/download/borders-decorative-borders-are-everywhere-an-expression-of-the-pleasure-we-findhttps://math.okstate.edu/geoset/Projects/Borders/howclass.htm

Consumer Education 3(1+2)

Objectives

This course aims to help the students:

1. To create awareness on the importance of consumer education and management at individual and family levels
2. To understand the financial levels at banking, crediting etc. by the consumer
3. To create awareness among the consumers about their problems, rights, responsibilities and food adulteration and durable goods
4. Identification of food adulterants
5. Learning about the calculations of income tax, cost of credit, installment buying etc.
6. Practical applications of consumer redressal forum

Theory

Consumer: definition, types, characteristics of Indian consumers. Consumer problems and vulnerability at market place. Consumer rights and responsibilities. Guidelines for good buying: durable and nondurable goods, house/apartments. Consumer service providers. Consumer movement in India. Consumer Protection Act and its constituent Acts in consumer welfare, consumer welfare organizations. Consumer redressal forum. E-consumerism.

Practical

Understanding and identification of consumer problems related to Weights and Measures, ATM and credit cards, Banking services, Collection and detection of food samples for adulteration

– Spices– Milk and Milk Products, Ghee and oils, Collection and detection of food samples – Rice and Dhals, Reviewing of Misleading, advertisements through print media, Reviewing of Misleading advertisements through electronic media, Evaluation of consumer products, Visit to consumer protection Organizations, Review of case studies of consumer disputes redressed, Planning for exhibits on consumer education, Preparation of exhibits for consumer education, Organizing exhibition for consumer education and e consumerism.

Suggested Readings

1. Clarke John, Newman Janet, Smith Nick, Vidler Elizabet and Westmarland Louise (2007) Creating Consumers. New Delhi-Sage Publications
2. Eastwood David B (1997). The micro Economics of Consumer Behaviour Houston: Dame Publications, INC.
3. Himachalam (1998). Consumer protection and Law. New Delhi: APH Publishing Corporation
4. Majumdar Ramanuj (2010). Consumer Behaviour Insights from Indian Market. New Delhi: PHI Learning Private Limited
5. Mike L (1986). The Complete Interior Decoration. United Kingdom: Mc Donald
6. Rice Nickel and Tucker (1976) Management in Family Finance. John Wiley and Sons, New York
7. Seetharaman P and Sethi M. (2002) Consumerism Strategies and Tactics. CBS Publishers and Distributors New Delhi
8. Verghese M N, Ugale W N and Srinivasan K (1997) Home Management. New Delhi: New Age International

Adolscent Development 3 (2+1)

Objectives

1. To understand the ways in which physical, cognitive, social, emotional, and personality development interact in development of adolescent
2. To educate about the contemporary issues in adolescent development, challenges and issues

Theory

Meaning, Significance, characteristics and developmental tasks, significance of the stage - Theoretical perspectives on adolescence –biological, psycho-analytical, psycho-social, social-cognitive and cultural , lifespan perspective, learning perspective, humanistic perspective, ecological perspective, socio cultural perspective, and the positive youth development perspective -Physical and sexual development in adolescence - physical transition from child to adult, puberty causes and changes, psychological impact of puberty, early and late maturation and its psychological implications, body image and its psychological implications -Cognition during adolescence**,** theoretical perspectives on adolescent cognitive development, gender differences in mental abilities - Socio-emotional development during adolescence - transition in emotions, heightened emotionality, common emotional patterns, coping mechanism, maturity and adjustment, early and late maturation and its psychological implications, socialization difficulties in social transition, social attitudes and behaviour, influence of peers, conformity and self-assertiveness - Identity development; Erikson's identity Formation theory , Marcia's Statuses Identity; identity diffusion,

identity foreclosure, identity moratorium, self-concept - Moral development during adolescence and value orientation – theoretical perspectives - Mental Health and resilience, Life skills and their importance - Challenges of adolescence sexuality, aggression, delinquency, understanding of AIDS, substance abuse, alcoholism, personality disorders, depression, suicide, eating disorders, health problems, psychological problems, social problems- dating and relationships - Guidance and Counselling for adolescents– need and importance – changing roles in family and society.

Practical

Survey on adolescent problems and conflicts, Attitude towards sexuality/Substance abuse - Profile of behavioural problems through Case study, gender issues of adolescence – adolescents future planning and orientation study through interviews – Tests related to skills and abilities of Adolescence: e.g., Adolescence Girl's Empowerment Scale- Differential Aptitude Test, Behaviour Problem checklist (CBCL)- Problem solving ability test (PSAT) Guidance need inventory, Life Style Scale, Anecdotal records.

Suggested Readings

1. Berk LE and Meyers AB. 2010. Infants, Children, and Adolescents. 7th edn. Prentice Hall, PTR.
2. Conger JJ. 1977. Adolescence and Youth: Psychological Development in a Changing World. Harper and Row, New York.
3. Dandekar K. 1996. The Elderly in India. Sage Publications, New Delhi.
4. Hayslip B and Panek P. 1989. Adult Development and Aging. Harper and Row.
5. Newman BM and Newman PR. 2003. Development Through Life: A Psycho Social Approach. Cenhahe Learning, Boston.
6. Hazen E P, Goldstein M A, Goldstein M C (2011). Mental Health Disorders in Adolescents: A Guide for Parents, Teachers, and Professionals. Rutgers University Press: New Brunswick, NJ.

Adulthood Development 2 (1+1)

Objectives

1. To acquaint students regarding the developmental areas of adults and its theoretical orientation
2. To develop understanding of changes and adjustments in adulthood

Theory

Emerging adulthood, importance, stages, characteristics and conflicts - Meaning, characteristics and developmental tasks of adulthood, stages of adulthood - Principles of adult development; Four principles of adult development and aging - Theoretical and ecological perspectives of adult development: Psychosocial theory, Peck elaboration of Erickson, Levinson's theory, Sheehy's adult transition, Erikson's Psychosocial theory, Identity Process Theory, Activity Theory, Socio-emotional Selectivity Theory - Theoretical perspectives in adult development - Bio-psychosocial perspective, Ecological perspective, Life Course perspective. Klaus Riegel's Dimensions of Development Theory -- Antecedent influences for growth and development during adulthood - Physical, motor, social, emotional, and cognitive and language characteristics of Early, Middle and Late adulthood - Personality development, Happiness and satisfaction, life style choices, marriage and family transitions - Career, theories of career choice, Job satisfaction - Adjustments during adulthood:

Menopausal adjustments, Empty nest, career changes, retirement, leisure - Health during adulthood and prevention of chronic diseases, physical and neuro-cognitive disorders - Old age: demography of old age, theories of biological aging - Old age: Care during old age - Antecedent influences for developmental changes during old age - Adjustment to death, widowhood, dying and bereavement - Counselling for adults and the aged – need and importance.

Practical

Administering of adulthood scales on personality - Preparation of interview schedule for adults on life satisfaction - Interviews on career satisfaction - Interviews on dual role burden for women - Case study on health condition - FGDs on ageing problems - Content analysis of films, books on adulthood conflicts and resolutions - Visits to institution of aged and their evaluation - record writing and presentation.

Suggested Readings

1. Dacey J S and Travers J F (2002). Human Development - Across the Lifespan. McGraw Hill, Boston.
2. Dandekar K (1996). The Elderly in India. Sage Publications, New Delhi.
3. Hayslip B and Panek P (1989). Adult Development and Aging. Harper and Row.
4. Hurlock E B (2003). Developmental Psychology - A Life Span Approach. Tata McGraw Hill, New Delhi.
5. Kail R V and Cavanaugh J C (2004). Human Development - A Life-Span View. Thomson-Wadsworth, United States.

Project Management 3 (2+1)

Objectives

1. To develop understanding regarding project, project management and its techniques
2. To develop skill in writing a project proposal

Theory

Project – Concept, characteristics and types; Project Management – Concept and elements; Phases of Project Life cycle- *initiation, planning, execution, and closure;* Formulation of Project Proposal- Concept and need; Elements of Project Formulation- Project Appraisal-Feasibility Analysis, Techno-Economic Analysis, Input Analysis; Financial Analysis; Cost- Benefit Analysis; Network Analysis; Project management techniques- PERT and CPM.

Practical

Visit to institutions managing following types of projects: Technology generation project; Transfer of Technology (ToT) project; Women entrepreneurship project; Women and child development project; Agriculture development project; Rural development project; Preparation of reports of the institutions visited; Presentation of report; Visit to state level funding agencies; Preparing reports of the funding agencies visited; Presentation of report; Preparation of a short-term project proposal; Presentation of project proposal; Working on project management techniques: PERT, CPM.

Suggested Readings

1. Goel B B. 2008. Project Management- Principles and Techniques. Deep and Deep Publications Pvt. Ltd. New Delhi.
2. Agarwal M. R. 2010. Project Management. Garima Publications, Jaipur (Raj.)

Study tour 2 (0+2) Non-Gradial

To be conducted for 10-12 days after 5th semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organizations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ states and the social and cultural differences existing in the country. After the visit, the students will be submitting a report/ make a presentation.

Semester VI

Nutritional Biochemistry 3 (2+1)

Objectives

1. To understand the relationship of chemical and physiological functions of various specialized cells of the body to their roles in metabolism and nutrition
2. To describe the major pathways of energy metabolism, how they are regulated, modified during different physiological states and their consequences
3. To understand the biochemical aspects of nutrients and utilization of nutrients in the body

Theory

Introduction: Definition, historical development, relevance for home science. Carbohydrates: Definition, classification, structure, Glycolysis, TCA cycle. Lipids: Definition, classification, structure, B-oxidation. Protein and amino acids: Definition classification, structure, path of entry of amino acids into metabolism, urea cycle. Role of vitamins and minerals in metabolism. Nucleic acid: Nitrogenous base, nucleotides, DNA and RNA structure. Enzymes: Nature, classification, mechanism of enzyme action and factors affecting its inhibition, coenzymes and cofactors. Brief orientation of biochemical energetic and biological oxidation. Acid base balance.

Practical

Qualitative analysis of carbohydrates. Qualitative analysis of amino acids. Qualitative analysis of protein. Determination of acid value, saponification value and iodine number. Demonstration on estimation of nitrogen by Kjeldhal method. Demonstration on estimation of fat by Soxhlet method. Determination of pH.

Suggested Readings

1. Conn, E.E. and Stumpf, P.K. 1976 / 2002 Outlines of Biochemistry. John Wiley and Sons, New Delhi.
2. Deb, A.C. 1996. Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd. Calcutta.
3. Murray, R.A. Grammer, D.K. Mayes, P.A. and Rodwell, W. 1996. Harper's Biochemistry, Prentice Hall of India Pvt. Ltd, New Delhi.

4. Rao Ranganathan, K. 1975. Textbook of Biochemistry. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Plummer, D.T. 1971. Introduction to Practical Biochemistry. Tata Mc-Graw Hill.

Human Nutrition 3 (2+1)

Objectives

1. To equip the students with basic knowledge about macro- and micro- nutrients and role in human nutrition
2. To enable them to understand the rich sources, deficiency and toxicity of various nutrients

Theory

Historical development of nutrition. Definitions of terms used in nutrition -Nutrients, RDA, Daily Value, Balanced diet, Food pyramid, My plate, Glycemic index, Glycemic load, Food Security, Nutritional Security, BMR, BMI, health, functional foods, phytochemicals, nutraceuticles, dietary supplements. Energy, units, sources and requirements, fuel value of foods, methods of measuring energy value of foods, energy requirements of body, physical activity and thermogenic effects of foods, BMR and factors affecting methods of measuring BMR and measuring TEF. Macronutrients: classification, functions, sources, requirements, digestion, absorption of carbohydrates. Lipids, types, functions, sources, requirements, digestion, absorption and health conditions associated with lipids. Classification, functions, sources, requirements, digestion, absorption of proteins, classification and functions amino acids, health conditions associated with proteins. Fibre- types, source and importance in human health. Vitamins, classification, functions, sources, requirements, deficiency and toxicity of fat soluble vitamins A, D, E and K and water soluble vitamins C, B-complex- thiamine, riboflavin, niacin, folic acid, biotin pyridoxine and cyanacobalamine. Minerals, classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorous, magnesium, sodium, potassium, chloride, micro minerals, iron, iodine, fluorine, copper, zinc. Factors affecting bioavailability of important minerals. Water, functions, sources, distribution in body, water and electrolyte balance.

Practical

Serving size of common dishes. Planning and preparation of nutrient rich dishes: protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin and ascorbic acid. Calculate calorie and cost of dishes prepared for above nutrients. Evaluation of three days energy balance. Planning and preparation of dishes based on simple processing techniques to improve bioavailability of nutrients. germination, Fermentation, Mutual supplementation, Malting and others. Planning and preparation of low-cost nutritious recipes.

Suggested Readings

1. Agarwal A and Udipi S (2014), Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
2. Gibney M J, Lanham-New S A, Cassidy A and Voster H H (2019), Introduction to Human Nutrition, 3rd edn, Wiley-Blackwell Publication.
3. ICMR-National Institute of Nutrition (2020), Nutrient Requirement of Indians: A Report of the Expert Group, ICMR.

4. Mann J and Truswell S (2012), Essentials of Human Nutrition. 4th edn. Oxford University Press.
5. Sehgal S and Raghuvanshi R S (2007), Text Book of Community Nutrition. ICAR Publication.
6. Srilakshmi B (2018), Nutrition Science, 6th edn. New Age International (P) Ltd Publishers, New Delhi.

Traditional Textiles and Costumes of India **3 (2+1)Objectives**

1. To learn the characteristic features/designs of the traditional textiles and costumes of different states of the India
2. To learn the characteristic features of the traditional textiles and style in costumes of different states of the India
3. To develop an understanding of the classification of traditional textiles based on the process of making it
4. To develop an understanding of the methods and materials used in processing and production for different categories of traditional textiles
5. To develop an understanding of the techniques of traditional embroideries, prints and woven textiles
6. To inculcate skill for adaptation of traditional textiles' designs and costumes' styles in contemporary textiles and apparels

Theory

Historic perspective, classification and importance of traditional Indian textiles and costumes in Textiles and Apparel industry, Introduction of Textile Arts -Embroideries, rugs, carpets, shawls, sarees and wraps, Factors affecting diversity of textiles and costumes of India: Geographical factors, socio-economic factors, customs, traditions and religious factors. Impact of adaptation of traditional motifs and costumes in contemporary apparel designing. Traditional Indian costume of Northen India- Jammu and Kashmir, Punjab and Haryana. Western India- Rajasthan, Gujrat and Maharashtra, Southern India-Andhra Pradesh, Tamil Nadu, Kerala and Karnataka, Eastern India-Orissa, West Bengal, Assam, Nagaland, Meghalaya, Manipur, Arunachal, Mizoram, Tripura. Central India-Uttar Pradesh, Madhya Pradesh and Bihar. Style of costumes; stitched garment, draped garment, head covers, wraps, Importance of Geographical Indications for traditional Indian textiles. Woven textiles (Origin, material and techniques used) Shawls from Kashmir, Assam and Nagaland, Kota Doria, Patola, Sujani, Tangaliya, Pachhedi, Chanderi, Maheshwari, Brocades, Dacca muslin, Baluchari, Jamdani Tangail, Paithani, Himroo, Amru, Dharvaram, Sambhalpuri, Vichitrapuri, Venkatgiri, Gadwal, Narayanpet, Ilkal, Khann, Kanjeevaram, Lepcha, Pochampalli, Ikat. Printed, painted and dyed textiles (Origin, material and techniques used), Painted textiles- Patachitra, Pichhavai, Worli and Phad mordant painted textiles Kalamkari- Masulipatnam and Srikalahasti, Madhubani, Printed textiles- Calico printing and Handblock printed- Ajrakh, Rogan, Sanganeri, Bagh, Dabu, Yarn resist dyed Patola, Mashru, Ikat, Bandhej; Fabric resist- Sugadi, Bhandej, Laheriya.

Practical

Documentation of motifs and sample preparation of traditional textiles. Creative projects: Preparation of one article by adapting traditional motifs and embroidery in contemporary textiles. Preparation of portfolio and collection of visuals that depict the different traditional textile and its application in contemporary apparel designing (Pictures of traditional textiles with the descriptive

analysis and Pictures of the traditional costumes with constructional details). Visit to National craft museum and exhibition/art galleries.

Collection of varied style of male and female traditional costumes of different states of India for hands on experience. Documentation of traditional textiles and styles in traditional costumes and development of portfolio: (Collection of images and samples for development of theme board, Development of storyboard, Development of range of textile/apparel product and Display and presentation of portfolio). Creative projects: organizing exhibition/fashion show. Creating dolls display of traditional costumes of different states. Preparation of mini costumes of both male and female in group assignments and project work. Visit to National craft museum and exhibition/art galleries.

Suggested Readings

1. A Compendium of Indian Handicrafts and Handlooms covered under Geographical Indications (GI), Ministry of Textiles, Govt. of India, New Delhi
2. Bhatnagar, Parul. (2004). Traditional Indian Costumes and Textiles, Abhishek Publications, Chandigarh
3. Bhatnagar, P. (2005). Decorative Design History in Indian Textiles and Costumes. Chandigarh, Abhishek Publication.
4. Bhatnagar, P. (2006). Traditional Indian Costumes and Textiles. Chandigarh, Abhishek Publications.
5. Chisti, R.K. (2013). Sari Tradition and beyond. Roli books Pvt Ltd. New Deli.
6. Gillow and Barnard N. (2014). Indian Textiles. 1st edn. Thames and Hudson, London.
7. Gosh, G. and Shukla G. (2014). Ikat Textiles of India. A.P.H. Publishing New Delhi.
8. Karolia, A. (2019). Traditional Indian Handcrafted Textiles: History, Techniques, Processes, Design. Vol I and II (1st edn). New Delhi: Niyogi Books Pvt. Ltd.
9. Mehta, R J. (1970). Master Piece of Indian Textiles. D. B. Taraporevale Sons and Co. Private Ltd.
10. Treasure of Indian Textiles. 1980. Calico Museum. Ahmedabad. Marg Publication Bombay

Principles of Management 2 (2+0)Objectives

The course aims to help students to-

1. Understand the nature of management
2. Know about the process of management
3. Study the systems approach to management

Theory

Management: Concept, nature, Importance, Management as a profession, Universality of management, Professionalism of management on India, Tasks of a professional manager, Motivating factors of management: Values- concept, significance, characteristics, sources, classification, development of value pattern. Goals - Concept, classification, SMART goal setting, strategies for achieving SMART goals. Standards - Concept, classification; Standard of living - Inter - relatedness of Values, goals and standards. Resources - Definition, Meaning and importance, types, characteristics, factors affecting their use and guidelines, Role of resources in management, conservation of

resources; Management of household resources: Time - tools and process of time management, time plan and steps in making time plan, Factors affecting time use; GANTT Chart - Energy - types and sources of energy - Functions of management, Management skills; Process of Management: Planning: Importance, types, characteristics and techniques, barriers to effective planning; Organizing: Meaning and importance, characteristics and techniques; Controlling: Definition, Concept, Importance, phases and factors; Evaluating: Definition, Need and types of evaluation - Decision making process: Concept, Importance, scope, types, steps and factors affecting decision making - Communication: Process, types of communication, barriers of communication - Systems approach to management: Conceptual framework of management, systems approach, sub - systems and interactions with other systems, Family - the managerial unit, the environment surrounding the family, management and changes in environment; Origin, classification and role of Motivation in Management.

Suggested Readings

1. Gupta, R.S., Sharma, B. D. and Bhalla, N.S. (1997) Principles and Practice of Management. Kalyani Publishers, New Delhi.
2. Gupta, S., Garg, N. and Aggarwal, A. (1993) Textbook of Home Management, Hygiene and Physiology. Kalyani Publishers, New Delhi.
3. Kaur, H and Macneil, C. (1994) Theory and Practice of Home management. Surjeet Publications, New Delhi.
4. Mullick, P. (1997) Handbook for homemakers. Kalyani Publishers, New Delhi.
5. Nickell, P. and Dorsey, J. M. (1959) Management in Family Living. Wiley Eastern Private Ltd., New Delhi.
6. Shakul, M. and Gandotra, V. (2006) Home Management and Family Finance. Dominant Publishers, New Delhi.
7. Varghese, M.A., Ogale, M. N. and Srinivasan, K. (1996) New Age International (P) Limited, New Delhi.

Computer Aided Designing-II 3 (0+3)

Objectives

The course aims to help students-

1. To draw the room plans for various activities
2. To draw the floor plans with different SQFT areas
3. To add the interior details in developed drawings

Practical

Developing a simple bubble diagram and schematic diagrams of various residential zones through CAD: Cooking, dining, living, Rest areas, entrance, operative zone, service zone - Drawing the floor plans of various rooms through CAD drawing: kitchen, dining room, bedroom, living room - Drawing the conceptual floor plans with different SQFT area - Dimensioning the floor plans - Adding Text to Floor plan - Adding furniture to floor plan - Drawing elevations of different types of residential buildings through CAD - Creating 3-D Models of structural features using viewport

- Creating varietal effect through hatching technique in CAD - Use of Rendering Techniques in Interiors through CAD - Developing conceptual drawing of small residential project - Printing and plotting a drawing.

Suggested Readings

1. AutoCAD 2017: A Power Guide for Beginners and Intermediate, 2nd edn, Create Space Independent Publishing Platform.
2. CADArtifex. 2016.
3. Ching, F. D.K. 2015.Architectural graphics. 6th edn. Wiley
4. Chopra, A. and Huehls, R. 2017. Sketch Up for Dummies (For Dummies (Computer/Tech)) 1st edn, For Dummies
5. Cline, L. 2014. Sketch Up for Interior Design: 3D Visualizing, Designing, and Space Planning, 1st edn. Wiley Secondary Reading.
6. Fane, B. 2016. AutoCAD for Dummies, 17th edn, For Dummies.
7. Obermeier, B. and Ted Padova, T. 2016. Photoshop Elements 15 For Dummies 1st Edition, For Dummies
8. Onstott, S. 2010. Enhancing Architectural Drawings and Models with Photoshop, 2nd Edition, Sybex.
9. Tondreau, B. 2011. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) 1st edn, Rockport Publishers

Marriage and Family Dynamics 3 (2+1)Objectives

1. To provide the knowledge about the dynamics of Contemporary marriage and family system in India
2. To understand Family stress and crisis
3. To empower the students by providing them knowledge about the laws and Acts related to marriage and Family life
4. To develop an understanding about the need and importance of family life education, sex education and family planning
5. To prepare the students to work as Marriage and Family Counselor

Theory

Marriage: Definition, philosophy, past and present concept of Hindu Marriage, Goals and Functions of Marriage - Characteristic features of Hindu, Muslim and Christian Marriage -Types and Forms of Marriage in India (Ancient and Prevalent Forms) - Readiness for marriage – Definition, Meaning and importance of readiness, Areas of readiness for marriage. (Identifying characteristics of readiness for marriage) - Mate Selection: Meaning, model/method of mate selection - field of mate selection - Theories of mate selection (Ways of mate selection in tribal India. Factors responsible for wrong mate selection - Guidelines for mate selection,) - Factors influencing mate selection and desirable qualities in mate -Trends in mate selection- Newspaper ads for marriages, Online matrimonial sites; their use and problems and prospects - Dating, Courtship and engagement: Meaning and objectives of Dating, courtship and engagement - Importance of engagement - Wedding:

Definition meaning and purpose of Wedding ceremonies rituals and ceremonies of marriage in different religions of India - Marital roles and behaviour- Definition, importance and concept of marital roles (marriage as status and role transition) Changing gender roles - factors responsible for change in gender roles, role conflict - Marital Adjustment and Success: Definition, Areas of marital adjustment - types of marital relations and adjustment - factors influencing marital adjustment - marital adjustment over the family life cycle, obstacles in marital adjustment, improving marital adjustment - marital adjustment techniques , general technique of resolving differences - Marital Success and criteria of Marital Success - Marital dissolution: Definition, types of marital dissolution, Voluntary and Involuntary, Causes of Marital Dissolution, Separation distress and factors effecting it - Divorce, factors responsible for divorce, consequences of divorce on spouse and children , factors responsible for an increase in the rate of marital dissolution, factors responsible for refraining from divorce after marriage failure, social process of marital failure and divorce, children's response to divorce, children as weapon against divorce, Adjustment to Divorce - alternatives to marriage- Singlehood, heterosexual cohabitation/consensual union, homosexual union, reasons behind it and merits and demerits.

Family: Meaning, Definition and Characteristics of Family functions, forms/types of family. Family structure and relationship in India-Pattern of changes in family structure and relationships in India - Impact of globalization, industrialization, technological advancement and immigration on family structure and functions - family (education and employment of women) and Extra familial factors (technology, peer group, society) responsible for the change and consequences of these changes on the family life and society - Family life cycle: Definition, Stages of Family Life Cycle, importance of studying family life cycle, - developmental tasks, developmental tasks of stages of family life cycle - Role expectation of different family members at different stages of family life cycle - Forms of Families; typical and alternative forms of families- Characteristics of single parent families, female headed families, single child families, childless families, adoptive families, dual earner families, reasons behind alternative form of family and their merits and demerits. family stress – Definition, types/categories of stressors, variables affecting family/response to stress, Hill's ABCX Mode/theory of family stress, causes of family stress, effects/impact of family stress, manifestations/recognizing symptoms of family stress, stress coping strategies, correlates of family stress - Family crisis- Definition, Characteristics, Stages of crisis. Effect of crisis and Adjustment to crisis factors which affect meeting the crisis, general things to do in times of crisis – Marriage Laws and acts - Dowry, adoption, divorce and inheritance in India - Education for Parenthood and Family Planning, Family Life Education, Concept, Definition, objectives of Family Life Education; role of family and related agencies in Family Life Education, Family Planning: Meaning; objectives Importance and Methods - Family counselling - Fundamentals of Premarital, marital and family counselling: Objectives and Importance.

Practical

Study of motives of marriage and trends in mate selection - Study of characteristics of nuclear, joint, atypical and alternative forms of families - Study of marital roles and adjustments - Study of changing roles and relationship in marriage and family system across family life cycle - Study of family crisis and coping strategies in families - Visit to marriage bureau and family counselling centres - Interviewing, assessment and developing case studies on people undergoing, Premarital, marital and family stress – reviews of books and films on marital relationships, conflicts and coping.

Suggested Readings

1. Adams, B. N. (1980). The Family: A Sociological Interpretation. Chicago: Rand McNally College Publishing Company.
2. Ahuja, R. (2005). Indian Social System. New Delhi: Rawat publication.
3. Atkinson, B.J. (2005). Emotional Intelligence in Couple Therapy. NY Norton
4. Benokraitis, V.N. (2014). Marriage and families. Delhi: Pearson Publication.
5. Brownman, A.H.1970. Marriage for Mordens. MacGaw-Hills Inc. USA.
6. Gottman, J. M. (Ed.) (2004). The Marriage Clinic Casebook N.Y.: Norton (0-609-60809-0)
7. Gottman, J.M. (1999). The Marriage Clinic: A scientifically based marital therapy. N.Y.: Norton
8. Gottman, J, M. with DeClair, J. (2001). The Relationship Cure. N.Y. Crown (0-609-60809-6).
9. Gupta G.R. (2001). Family and Social Change in Morden India. Oxford University Press Kolkata India.
10. Gurman, A.S. and Jacobson N.S. (Eds) (2002). Clinical Handbook of Couple Therapy. 3rd edn, Newyork Guilford.
11. Kapadia, K. M. (1966). Marriage and Family in India. Kolkata: Oxford University Press.
12. Kumar, R. (2000). Violence against women. New Delhi: Anmol Publication Pvt. Limited.
13. Kurigan, G. (1974) A Family in India A Religious View the Huge Mountain
14. Landis J.T. and Landis, M.G. (1966) Building A Successful Marriage. Printice Hall, Inc Engelwood Cliff, New Jersey.

Diffusion and Adoption of Innovations 3 (2+1)

Objectives

1. To develop skills in identification of appropriate technologies for rural families
2. To develop competence in diffusion of need based technologies among rural families

Theory

Concept and elements of diffusion process. Perceived attributes of innovation. Adoption – definition, adoption process, Innovation – decision process. Types of innovation – decision and consequences of innovation. Factor affecting adoption of an innovation. Innovativeness and Adopter categories – concept, types and characteristics. Types of adopter categories and their characteristics. Change agents and opinions leader; change proneness – acceptance and resistance to social change. Appropriate technologies for rural families with special reference to Community science. Appropriate technologies for rural families with special reference to Drudgery reduction, Agriculture and Animal husbandry. Constraints in adoption of technologies. Behavior change communication (BCC) strategies.

Practical

Content analysis of adoption studies. Identification of key communicators and opinion leaders in locality, Identification and rating of appropriate technologies by rural women. Survey on adoption of appropriate technologies in community, Diffusion of need based appropriate technologies among rural families through various communication methods Farm and home visits. Diffusion

of need based appropriate technologies among rural families through various communication methods demonstration, group discussion, role play and exhibition etc. Case studies/Success stories regarding adoption of technologies, Identification of constraints faced by rural families in adoption of technologies, Preparation and presentation of report.

Suggested Readings

1. Dasgupta, S. (1989). Diffusion Agricultural Innovations in Village India. Wiley Eastern
2. Ltd, New Delhi.
3. Jalihal KA and Veerabhadraiah V. (2007). Fundamentals of Extension Education and Management in Extension. Concept Publ. Co.
4. Ray, G.L. (2005). Extension Communication and Management. Kalyani Publ.
5. Reddy, A.A. (1987). Extension Education. Shree Lakshmi Press, Bapatla. Guntur, AP.
6. Rogers, E.M. (2003). Diffusion of Innovations. 5 th Ed. The Free Press, New York
7. Somani, L.L. (2012). Extension Methodologies for Transfer of Agricultural Technology. Image Print Media, Udaipur
8. Supe, S.V. (2009). Text book of Extension Education. Agrotech Publishing Academy, Udaipur.

Semester VII
The student will choose elective courses as suggested

S. No.	Course Title	Credit Hours
1	Research Methodology	3 (2+1)
2	Statistical Methods	2 (1+1)
3	Elective courses (anyone specialization)	15
	Total	**20**

Research Methodology 3 (2+1)

Objective

To understand the meaning and importance of research, research procedures and develop skills in designing and executing research.

Theory

Research – Meaning and Importance; Types of Research; Qualities of Researcher; Steps of Research; Selection and delineating of research problem, statement of general and specific Objective, formulation of assumptions and hypothesis, planning research design, selection and development of data collection tools, collection of data, analysis and interpretation of data, drawing conclusion, writing research report. Understanding some concepts in research; Assumption, delimitations, operational definition, Measurement and its levels, Variable and their types. Hypothesis – Meaning, importance, characteristics and ways of stating hypothesis. Review of literature – Importance, sources of literature, organizing review, collection and presentation. Research Design; Historical or documentary, Experimental, Ex-post-facto, Survey, Case study, Field studies. Sampling – Meaning and importance; Sampling techniques, determine size of sample. Techniques of data collection;

Observation, interview and questionnaire, Projective technique. Scale and tests – Meaning and construction; validity and reliability of tools. Data analysis – tools and methods, interpretations of data, documentation and presentation. Summary, conclusion and recommendations; Writing abstract. The research report; Formal style of writing, chaptalization, heading, pagination, Tables and figures, Appendices and bibliography, acknowledgement. Writing for publications.

Practical

Identifying problem, formulating research hypothesis, questionnaire design, collection of secondary data, analysis and report writing. Use of reference management software, article writing.

Suggested

1. Bajpai SR. 1966. Methods of social Survey and Research. Kitab Ghar. Best W. 1983. Research in Education. 4th edn. Prentice Hall of India.
2. Carter Good V. 1966. Essential of Education Research. Appleton Century Profits, Educational Division, Mereelith Corp.
3. Kaul Lokesh. 1984. Methodology of Education Research. Vikas Publ.
4. Kerlinger F. 1973. Foundations of Behavioural Research. Rinehart Winetons.

Statistical Methods 2(1+1)

Objective

To develop understanding among students about sampling and data analysis techniques, methods of data analysis using various statistics.

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency and amp; Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial and amp; Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample and amp; two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Analysis of Variance, Analysis of One-Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles and amp; Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles and amp; Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness and amp; Kurtosis (Ungrouped Data). Moments, Measures of Skewness and amp; Kurtosis (Grouped Data). Correlation and amp; Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence

of Attributes for 2 ×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal BL. 2006. Basic Statistics. New Age International Publisher.
2. Gupta SC. 2006. Fundamentals of Statistics. Himalaya Publ. House.
3. Panse VG and Sukhatme PV. 1985. Statistical Methods for Agricultural Workers. ICAR.
4. Rao GN. 2007. Statistics for Agricultural Science. Oxford and IBH.
5. Snedecor GW and Cochran WG. 1968. Statistical Methods. Oxford and IBH.
6. Sprent P. 1993. Applied Non-Parametric Statistical Methods. 2nd edn. Chapman and Hall.
7. Sukthame and Ashok C. 1984. Sampling Theories and Surveys with Application. 3rd edn. ICAR.
8. Wetherill GB. 1982. Elementary Statistical Methods. Chapman and Hall.
9. William S. Cleveland. 1994. The Elements of Graphing Data, 2nd edn. Chapman and Hall.

ELECTIVES COURSES

Course Number	Course	Credit Hours
Elective-1 Food and Nutrition		
1.	Food Analysis	3 (1+2)
2.	Normal and Therapeutic Nutrition	3 (2+1)
3.	Food Product Development and Formulations	2 (1+1)
4.	Clinical Nutrition	2 (2+0)
5.	Diet and Nutrition Counseling	1 (0+1)
6.	Sports Nutrition	2 (2+0)
7.	Community Nutrition and Education	2 (1+1)
Elective-2 Apparel and Textile Science		
1.	Advance Draping Technique	3 (0+3)
2.	CAD- Pattern Making and Grading	2 (0+2)
3.	Quality Analysis in Textiles and Apparels	3 (2+1)
4.	Apparel Production Management	3 (3+0)
5.	Agro Textiles	2 (1+1)
6.	Recent Advances in Textiles	2 (2+0)
Elective-3 Resource Management and Consumer Science		
1.	Residential and Commercial Space Design	3 (1+2)

Course Number	Course	Credit Hours
2.	Colour and Lighting in Interiors	3 (2+1)
3.	Tourism and Hospitality Management	3 (1+2)
4.	Financial Management and Consumer Behaviour	3 (2+1)
5.	Work Space and Product Design	3 (1+2)
Elective-4 Human Development and Family Studies		
1.	Developmental Challenges in Children	3 (2+1)
2.	Methods and Materials for Teaching Young Children	3 (1+2)
3.	Computer application in ECCE	3 (1+2)
4.	Guidance and Counselling	3 (2+1)
5.	Parent Education and Community welfare Programs	3 (2+1)
Elective-5 Extension Education and Communication Management		
1.	Extension Program Management	3 (1+2)
2.	Extension Training Management	3 (1+2)
3.	Advertising and Social Marketing	3 (1+2)
4.	Public relations and Communication Management	3 (1+2)
5.	Web designing	3 (0+3)
	TOTAL	**20**

* The student will take anyone elective as per choice.

Food and Nutrition

Food Analysis 3 (1+2)

Objectives

1. To familiarize students with the equipment and techniques of food analysis
2. To enable students to analyze the composition of foods

Theory

Sampling and sampling techniques. Proximate analysis- Moisture, ash, crude fat, crude fibre, crude protein and carbohydrates by difference. Principles and methods of food analysis. Basic principles: Refractometry, polarimetry, densitometry, HPLC, GLC, spectrophotometry, electrophoresis, automatic amino acid analyzer. Determination of starch. Test for unsaturation of fats, rancidity of fats. Qualitative analysis of protein by Biuret method, Ninhydrin method, Lowry's method and Dye-binding method. Principles and methods for estimation of minerals: Atomic absorption spectroscopy, colorimetric, titrimetric and gravimetric methods. Methods for determining physical and rheological properties of food.

Practical

Proximate analysis: Moisture, ash and carbohydrate by difference. Demonstration of kjelplus, fibreplus, sox-plus. Estimation of sugar content of fruit and reducing and non-reducing sugars in cereals. Estimation of starch content of cereals Determination of iodine value and saponification number of fats. Estimation of minerals, iron, calcium and phosphorus. Estimation of vitamins: Ascorbic acid, Protein quality analysis, *in-vitro* method. Physical test for grain quality and rheological properties of foods.

Suggested Readings

1. AOAC. (2000). Association of Official Analytical Chemists. Washington, DC.
2. Joslyn, M.A. (1970). Methods in Food Analysis: Physical, Chemical and Instrumental Methods of Analysis. Academic Press. New York.
3. NIN. (2003). A Manual of Laboratory Techniques.
4. Pearson, D. (1973). Laboratory Techniques in Food Analysis. Butterworths and Co., London
5. Pomeranz and Yeshajahu. (1987). Food Analysis Theory and Practice. 2nd ed. AVI Publ. Company, Westport.

Normal and Therapeutic Nutrition 3 (2+1)

Objectives

1. To acquire basic knowledge of nutrient requirements, recommended dietary allowances, and dietary modification under different physiological conditions and disease conditions
2. To develop practical skills in planning and management of diets for the different age groups under normal/ physiological conditions keeping in mind the dietary guidelines and to modify the diet plans to suit the disease conditions

Theory

Determination of nutritional requirements- Basic principles of menu planning, factors affecting planning menus for individual and family. Steps involved in meal planning. Concept of calorie consumption unit. Factors (physiological and psychological) affecting food requirements of individuals, families and different groups of people. Classification of vegetarianism. Importance of balanced diets. Food exchange list. Use of food exchange list in diet planning. Introduction to normal nutrition- Food, nutrient requirement and menu planning of adults (male and female of all activities level), pregnant women, lactating women, Infants. Breast feeding, advantages of breast feeding, breast feeding during illness, feeding of pre-term baby, feeding problems. Weaning and complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, old age people Physiological and psychological changes during old age. Introduction to therapeutic nutrition- Definition of therapeutic nutrition/ Diet therapy, objectives of therapeutic diet. Principles of diet therapy and Importance and modification of normal diet to therapeutic diets. Therapeutic adaption- change in consistency, change in energy intake, change in nutrient, change in fiber, change in frequency of feeding, change in elimination of food. Methods of feeding- enteral feeding, parenteral feeding, advantages and disadvantages of these methods. Routine Hospital Diet- clear liquid diet, liquid diet, semi-solid diet, soft diet, normal diet, bland diet, high and low calorie diet, high and low protein diet, high and low fiber diet, low cholesterol diet etc. Aetiology, symptoms

and dietary management in acute and chronic fevers. Typhoid, influenza, tuberculosis. Viral and auto immune diseases- causes, symptoms and diet management. Allergy - causes, symptoms and diet management. etiology, symptoms and dietary management in gastrointestinal disorders- Diarrhoea, constipation, peptic ulcer, diverticular disease, inflammatory bowel disease, celiac disease, lactose intolerance etc. and other disorders. Aetiology, symptoms and dietary management in liver diseases- fatty liver, hepatitis, jaundice, cirrhosis of liver. Aetiology, symptoms and dietary management in cardiovascular disease, atherosclerosis and hypertension. Aetiology, symptoms and dietary management in diabetes mellitus. Aetiology, symptoms and dietary management in overweight and obesity and underweight. Aetiology, symptoms and dietary management in renal disease- nephritis, nephrotic syndrome acute renal failure, chronic renal failure etc. Aetiology, symptoms and dietary management in cancer.

Practical

Standardization of serving size portions. Planning, preparation and calculation of diets for different age Groups-Infancy, preschool age, school age, adolescent, adult, old age. Planning, preparation and calculation of diets for pregnant and lactating women. Planning, preparation and calculation of packed lunches, clear liquid diet, full fluid diet, soft diet, tube feeding diet, high calorie/ fiber diet etc. Planning, preparation and calculation of diets for following diseased condition- diarrhea, constipation, peptic ulcer, hepatitis, hypertension, atherosclerosis, diabetes, mellitus, overweight/ obesity.

Suggested Readings

1. Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication Delhi.
2. Antia, P. (1986). Clinical dietetics and nutrition. Oxford univ. Bombay
3. Raghuvanshi, R.S. and Mittal, M. (2014). Food Nutrition and Diet Therapy. Westvills Publication Delhi.
4. Srilakshmi, B. (1995). Dietetics. New Age international publishers, New Delhi.

Foods Product Development and Formulations 2 (1+1)

Objectives

1. To learn various aspects of product development and formulation related to production, quality evaluation
2. To understand the principles of marketing, branding, positioning, viability, feasibility and other commercial aspects of food products
3. To develop new products in practical situations and improve and innovate the existing food products
4. To develop entrepreneurship skills in the area of Food Product Development and Formulations

Theory

Concept of product development and food formulation. Techniques used in forecasting new products needs. New product ideas. Infra-structural requirement and contributory role of various disciplines involved in products development. Sequential steps of product development and food

formulation. Food ingredients; nutritional relevance: physical and chemical properties in relation to product formulation; nutritional changes due to processing. Evaluation of sensory characteristics and consumer acceptance of products. Consumer protection, nutrition labeling, Food packaging, advertising and marketing and economics. Improving success potential of new products, market exploration and acquisitions. Quality controls procedures employed in product development. Procedure for obtaining patents. Legal aspects of product development.

Practical

Sensory evaluation techniques: Recognition test; basic tastes, odour recognition, aroma perception. Exercises with other senses, tactile and pressure, kinesthetic, temperature, pain, auditory and colour. Threshold tests for basic tastes. Difference tests; paired, triangle and duo trio tests. Ranking test. Descriptive tests: flavor profile and dilution flavor profile. Scoring tests. Project: Product formulation and evaluation. Visit to a food industry.

Suggested Readings

1. Baker, R. C. (1988) Fundamentals of New Food Product Development (Developments in Food Science). Elsevier Science Ltd.
2. Prusa, K. and Gilbert, K. (2019) Food Product Development Lab Manual. Iowa State University, United States
3. Sharma, A. (2018) Food Product Development. CBS, India.

Clinical Nutrition 2 (2+0)

Objectives

1. To understand basis of RDA derivation and use knowledge to understand individual variations and provide personalized nutrition
2. To interpret clinical results and apply the findings in formulating therapeutic diet
3. To understand rationale and use of nutraceuticals and functional foods

Theory

Methods for estimating RDA: Basic terminology in relation to nutritional requirements; Methods for studying the nutrition Requirements: Population survey of dietary intakes of nutrients, Growth studies, Depletion and repletion studies, Nutrient balance studies, Use of isotopically labelled nutrients: Nutrient turnover, Obligatory losses of nutrients. Clinical results and their interpretation: Interpretation of clinical testing of blood serum and urine with particular emphasis on their interpretation related to nutritional status and disease (PEM, liver, cardiovascular and renal disorders, diabetes mellitus, underweight, overweight and obesity) Nutritional Biomarkers. Introduction to free radicals: Free radicals, reactive oxygen species, production of free radicals in cells, damaging reactions of free radicals on lipids, proteins, Carbohydrates, nucleic acids, Free radicals' theory of ageing, enzymatic and non-enzymatic antioxidant defence, synthetic antioxidants. Nutraceuticals and dietary supplements: Definitions of Nutraceuticals, Functional foods, Dietary supplements, Nutrigenomics, probiotics, Prebiotics and postbiotics, interaction between nutrients, infections and drugs, Nutraceutical factors in specific foods- Classification of Nutraceutical factors based on chemical nature and mechanism of action, Occurrence and Therapeutic uses of Carotenoids

(Lycopene, Lutein, Zeaxanthene, Astaxanthene), Quinones (Tocopherol), Proteins and Minerals (Melatonin, Glutathione, Shilajit, Carnitine), Phenolics and Polyphenolics (Reservetrol, Grapeseed extract, Tea, Pycnogenol, Avenanthramides from Oats, Rutin, Soy Isoflavones, Curcumin), Sulphur Compounds (Glucosinates), Essential Fatty acids (Fish oils, α- Linolenic acid), Dietary fibres and complex carbohydrates as functional food ingredients, Regulatory issues of Nutraceuticals and Dietary Supplements.

Suggested Readings

1. Baetge, E. E., Dhawan, A. and Prentice, A. M. (Eds). (2016). Next Generation Nutritional Biomarkers to Guide Better Health Care: 84th Nestlé Nutrition Institute Workshop, Lausanne, September 2014. Karger Medical and Scientific Publishers.
2. Das, L., Bhaumik, E., Raychaudhuri, U., and Chakraborty, R. (2012). Role of nutraceuticals in human health. Journal of food science and technology, 49(2), 173-183.
3. Elia, M., Ljungqvist, O., Stratton, R.J. and Susan, A. L. (Eds). (2013). Clinical Nutrition. Wiley, Germany.
4. Gupta, R. C., Lall, R., and Srivastava, A. (Eds). (2021). Nutraceuticals: efficacy, safety and toxicity. Academic Press.
5. Mahan, L.K. and Escott-Stump, S. (2000). Krause's Food, Nutrition and Diet Therapy. 10th Edition, W.B. Saunders Co., Pennsylvania.
6. Nutrient Requirement for Indians: Recommended Dietary Allowances and Estimated average requirements-2020. National Institute of Nutrition, India (nin.res.in).
7. Raghuvanshi, R.S. and Mittal, M. (2014). Food Nutrition and Diet Therapy. Westvills Publication Delhi.
8. Sobotka, L. and Forbes, A. (Eds.). (2019). Basics in clinical nutrition (Vol. 1, No. 5th). Galen.
9. Wildman, R. E., Wildman, R. and Wallace, T. C. (2016). Handbook of nutraceuticals and functional foods. CRC press.

Diet and Nutrition Counselling 1 (0+1)

Objectives

1. To develop the knowledge for understanding the concepts of diet, structural, compositional and nutritional importance of various diet
2. To develop the skills in communication, learn the counseling techniques, group process skills and behavior modification theories and develop the educational tools.

Practical

Communication to Promote Change; Interviewing, Counseling, Behavioral Modification, Modifying Cognitions, Motivation, Principles and Theories of Learning, Planning Learning, Implementing and Evaluating Learning, Group Dynamics, Delivery of Oral Presentations and Workshops, Planning, selecting and Using Media.

Suggested Readings

1. Baetge, E. E., Dhawan, A. and Prentice, A. M. (Eds) (2016). Next Generation Nutritional Biomarkers to Guide Better Health Care: 84th Nestlé Nutrition Institute Workshop, Lausanne, September 2014. Karger Medical and Scientific Publishers.

2. Das, L., Bhaumik, E., Raychaudhuri, U. and Chakraborty, R. (2012). Role of nutraceuticals in human health. Journal of food science and technology, 49(2), 173-183.
3. Elia, M., Ljungqvist, O., Stratton, R.J. and Susan, A. L. (Eds). (2013). Clinical Nutrition. Wiley, Germany.
4. Gupta, R. C., Lall, R. and Srivastava, A. (Eds) (2021). Nutraceuticals: efficacy, safety and toxicity. Academic Press.
5. Mahan, L.K. and Escott-Stump, S. (2000). Krause's Food, Nutrition and Diet Therapy. 10th Edition, W.B. Saunders Co., Pennsylvania.
6. Nutrient Requirement for Indians: Recommended Dietary Allowances and Estimated average requirements-2020. National Institute of Nutrition, India (nin.res.in)
7. Raghuvanshi, R.S. and Mittal, M. (2014). Food Nutrition and Diet Therapy. Westvills Publication Delhi.
8. Sobotka, L., and Forbes, A. (Eds.). (2019). Basics in clinical nutrition (Vol. 1, No. 5th). Galen.
9. Wildman, R. E., Wildman, R. and Wallace, T. C. (2016). Handbook of nutraceuticals and functional foods. CRC press.

Sports Nutrition 2 (2+0)

Objectives

1. To learn the selection of the right balance of carbohydrates, proteins, and fats to provide energy and build or maintain muscles, designing diet plans, and use of nutritional supplements
2. Understand the special nutritional requirements for physical activities related to sports and exercise
3. Apply the knowledge to improve the performance of sportspersons

Theory

Introduction, Nutritional considerations for sports / exercising person as compared to normal active person. Energy substrate for activities of different intensity and duration, aerobic and anaerobic activities. Fluid balance in sports and exercise, importance, symptoms and prevention of dehydration, Sports drink, Energy enhancers and other commercial sports food products. Macro Nutrients-Carbohydrate as an energy source for sport and exercise, Carbohydrate stores, Fuel for aerobic and anaerobic metabolism, Glycogen re-synthesis, CHO Loading, CHO composition for pre-exercise, during and recovery period. Role of fat as an energy source for sports and exercise. Fat stores, regulation of fat metabolism, factors affecting fat oxidation (intensity, duration, training status, CHO feeding), effect of fasting and fat ingestion. Protein and amino acid requirements, Factors affecting Protein turnover, Protein requirement and metabolism during endurance exercise, resistance exercise and recovery process. Important micronutrients for exercise- B complex vitamin and specific minerals. Exercise induced oxidative stress and role of antioxidants. Chronic dieting and eating disorder. Female athletic triad, sports anaemia Dietary supplements and ergogenic aids (nutritional, pharmacological and physiological). Use of Nutritional supplements in strength/ power sports and team sports- use, effects, efficacy and safety – Creatine monohydrate, Sodium bicarbonates, Nitrates – B-Alanine, Caffeine – Protein supplements – Fat burners.

Suggested Readings

1. Banardot, Dan. (2000). Nutrition for Serious Athletes.
2. Human Kinetics Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition. Edited by Judy A Driskell, Ira Wolinsky, CRC Press 2000.
3. Jeukendrup, A. and Gleeson, M. (2010). Sport nutrition: an introduction to energy production and performance (No. Ed. 2).
4. McArdle, W. D., Katch, F. I. and Katch, V. L. (2009). Sports and exercise nutrition. Lippincott Williams and Wilkins.
5. Satyanarayan, K., Nageshwar Rao. C., Narsinga Rao, B.S. and Malhotra, M.S. (1985). Hyderabad, National Institute of Nutrition. Human Kinetics. Recommended Dietary Intakes for Indian Sportsman and Women.

Community Nutrition and Education 2 (1+1)

Objectives

1. To develop awareness of the students about the magnitude of nutritional problems and develop ability to assess the problems and devise nutrition education material for them

2. To comprehend the importance and determinates of nourishment decision practices and apply standards of network appraisal and nourishment instruction to design the appraisal, execution observing and assessment of a focused in community nutrition intercession

Theory

Malnutrition- Definition and causes, PEM, Marasmus, Kwasiorkor and vicious cycle of malnutrition. Assessment of nutritional status, Clinical signs and symptoms, nutritional anthropometry, biochemical tests, biophysical tests and diet survey methods. Major nutritional problems prevalent in India and the state of Protein energy malnutrition, anaemia, vitamin A deficiency, iodine deficiency disorders, obesity, hypertension, atherosclerosis and diabetes mellitus. National programmes and role of national and international agencies in improving nutritional status of the community, Integrated Child Development Service (ICDS), supplementary Nutrition Program (SNP), Applied Nutrition Program (ANP), Mid Day Meal Program (MDMP), Vitamin A Prophylaxis Program and Anaemia Prophylaxis Programme, Food and Agricultural Organization (FAO), World Health Organization (WHO), United Nations Children's Fund (UNICEF), UNDP, CARE and other Voluntary and Government Agencies. Nutrition education- Objectives, methods and principles.

Practical

Assessment of nutritional status of an individual/community using anthropometry and dietary survey, Preparation of schedule, Survey work, Analysis of data, Writing of report. Visit to local health centre to identify clinical signs and symptoms of nutritional problems. Identification of adulterants in common foods. Visit to an ICDS Block Development of audio visual aids- radio script, popular article, chart/posters, leaflets etc. Planning, implementation and evaluation of nutrition education for a target group.

Suggested Readings

1. Bamji, S.M., Rao, P.N. and Reddy, V. (2003). Textbook of Human Nutrition. Lord and IBH Publishing Co Pvt Ltd.
2. Jelliffe, D. B. (1966). The Assessment of the Nutritional Status of the Community, WHO Geneva.
3. Salil, S. and Rita, S.R. (2007). Textbook of community Nutrition ICAR publication New Delhi.
4. Sehgal, S. and Raghuvanshi, R.S. (2007). Textbook of Community Nutrition. ICAR, New Delhi.
5. Swaminathan, M. (ed.) (1998). The First Five Years: A Critical Perspective on Early Childhood Care Education in India. Sage Publication. New Delhi.

Apparel and Textile Science

Advance Draping Techniques 3 (0+3)

Objectives

1. To enable the students to make pattern from sketch /photograph using draping technique
2. To enable the students to obtain perfect fit and harmony between the fabric and design of the garment

Practical

Draping, trueing and stitching– dartless shirt, surplice front, bustier; Draping and stitching skirts; Draping collars, sleeves, lowered exaggerated armhole sleeve; Cowls; Flounces, ruffles and peplums; Dresses – sundress and sculptured dress; Draping knits; Designing custom clothing. Analysis and presentation.

Suggested Readings

1. Bane A. 1996. Creative Clothing Construction. Mc Graw-Hill.
2. Connie Amaden-Crawford. 1989. The Art of Fashion Draping. Fair Child Publ.
3. Janine Mee and Michal Purdy. 1987. Modelling on the Dress Stand. BSP Professional Books.
4. Natalie Bray. 1994. Dress Fitting. Blackwell.

CAD–Pattern Making and Grading 2 (0+2)

Objectives

1. To impart skill in Computer Aided Designing in Apparel Designing
2. To learn skill in pattern making and grading using CAD software

Practical

Introduction to pattern making software. Basics of pattern making tools (System and general tool bar, Edit tool bar, Accessories tool bar, Insert tool bar, Modify tool bar and Advance tool bar). Basics of pattern making menus (File menu, Edit menu, Piece menu, Grading menu, Pleat menu, Dart menu, Design menu, View menu, Option menu and Help menu). Creating grading basic patterns (Bodice front, back and sleeve, Skirt front and back).

Fundamentals of patternmaking software. Detailed use of drawing and editing tools. Creating basic sloper/ pattern set- bodice front and back, skirt front and back and sleeve. Development of sloper/patterns of selected designed dresses using pattern making software. Grading sloper/ patterns in pattern making software. Marker making in pattern making software by manual and automatic methods. Preparation of portfolio of developed sloper/pattern.

Suggested Readings

1. CAD pattern making software manual
2. Davis L. Msrisn 1980 Visual Design in Dress, Prentice Hall.
3. Rene, W. C. 1997. CAD for Fashion Design. Prentice Hall.
4. Taylor, P. 1990. Computers in Fashion Industry. Heinemann Publications.
5. Veinsinet, D. O. 1987. Computer Aided Drafting and Design-Concept and Application
6. Winfred, H. A. 1992. CAD in Clothing and Textiles. BSP Professional Books, London.
7. Winfred Aldrich. 1992. CAD in Clothing and Textiles. BSP Professional Books.

Quality Analysis in Textiles and Apparels 3 (2+1)

Objectives

1. To inculcate knowledge on quality control aspects
2. To impart knowledge and hands on experience on textile testing procedures
3. To impart skill in Inspection and quality analysis of different apparels

Theory

Importance of quality control and textile testing and introduction to various organizations/ institutes dealing with textile testing. Sampling techniques of fibre, yarn and fabric for testing. Standard conditions of testing and their importance. Testing of fibre dimensions- length, thickness, fineness, crimp, moisture content, strength, elasticity, linear density, and fibre imperfections. Testing of yarn dimensions: count, twist, single yarn strength and elongation, lea strength, evenness, hairiness, crimp, moisture regain, burst strength, pilling and yarn imperfections. Testing of fabrics- Physical, mechanical, comfort, colourfastness and fabric imperfections (physical testing of fabrics - thickness, GSM, fabric count, drapability, thermal conductivity, shrinkage, stiffness, elongation and crease resistance, Mechanical testing of fabrics- tensile strength, tear strength, dimensional stability, abrasion resistance, bending length and flexural rigidity, Testing of Comfort properties of fabrics- heat transfer, thermal protection, air and moisture permeability, water absorption and water repellence, Tests for colour fastness- washing, perspiration, light, rubbing and dry cleaning). Accepted Quality level (AQL) - Pre-production, production and post-production inspection of fabrics, sewing threads, buttons, zippers, buckles and ancillaries like linings and interlinings, labels and packaging material. Statistical quality control (SQC)- Different statistical techniques and their application in textile and apparel testing.

Practical

Demonstration of fibre testing for length, thickness, fineness, crimp, moisture content, strength, elasticity, and linear density. Demonstration of yarn testing for count, twist, single yarn

strength and elongation, lea strength, evenness, hairiness, crimp, moisture regain, burst strength and pilling. Physical testing of fabrics for testing thickness, GSM, fabric count, drapability, thermal conductivity, shrinkage, stiffness, elongation, and crease resistance. Mechanical testing of fabrics for testing tensile strength, tear strength, dimensional stability, abrasion resistance, bending length and flexural rigidity. Testing for comfort properties of fabrics for heat transfer, thermal protection, air and moisture permeability, water absorption and water repellence. Quality analysis of selected apparels- women's *kurti*, men's shirt and t-shirt. Visit to textile testing laboratory/ Quality control department in a textile or apparel industry.

Suggested Readings

1. Booth J E (1996) Principles of Textile Testing. CBS Publishers and Distributors Pvt. Ltd, Delhi.
2. Grover E B and Hamby D S (2011) Handbook of Textile Testing and Quality Control. Wiley India Pvt. Ltd.
3. Goel A and Kholiya R (2014) Textile Testing A Laboratory Manual. University Press. G.B. Pant University of Agriculture and Technology, Pantnagar.
4. Kothari V K (1999) Testing and Quality Management. IAFL Publications.
5. Mehta P V, Satish P E and Bhardwaj K (1998) Managing Quality in the Apparel Industry. New Age International Publishers.
6. Paul J (2005) Textile Testing. APH Publishing Corporation.
7. Rao J V (2008) Quality Evaluation. NITRA Handbook.
8. Saville B P (1999) Physical testing of textiles. Woodhead Publishing Limited.

Apparel Production Management 3 (3+0)

Objectives

1. To make students aware of the whole apparel production system
2. To endow the students with the advanced apparel production process
3. To introduce students with various trends in management of Garment industry
4. To familiarize students with apparel costing methods and pricing techniques

Theory

Introduction to apparel industry (apparel product types, organizational structure and sectors of the garment industry, developments in recent years, opportunities and challenges in Indian apparel sector, overview of global apparel industry, major trends in international apparel technological concepts). Different departments of apparel industry and their functioning (Design department, Marketing and business development department, Purchasing department, Finance department, Production department, Operations department). Apparel Production Technology (Material sourcing, Cutting technology- Forms of spreading for different types of fabrics, types of spreading machinery. Cutting techniques, considerations of cutting parameters for different fabrics, cutting machines and its working principle, fusing technology: Fusing materials, components of fusing, types of resin coating and its applications. Fusing machine types, working principle and their application, Sewing technology: Features, mechanism, working principle and application of single needle lock stitch (SNLS) machine, double needle lock stitch (DNLS) machine, over lock machine,

blind stitch machine, button sewer and buttonhole machines, bar tack machines; stitches and seams, feed mechanism and working aids, needles and threads and Pressing and finishing technology: Classification of pressing, components of pressing/finishing machinery and equipment. Thread trimming, quality checking of garments and pressing, Apparel Production Systems). Warehousing-Assortment and storage methods. Packing: Function and scope of packing, packing methods, instructions, materials, weight, ratio, and labelling considerations for shipment by air and sea, packing marks. Capital management: Support system – banks, govt. agencies and institutions. Fixed and working capital. Cost accounting: Classification of cost elements- direct and indirect. Determination of factory cost, administration cost and sales cost of an apparel product. Manufacturing cost account statement - preparation and analysis, cost behaviour patterns – fixed, variable, semi variable. Calculations related to job order costing and process costing. Pricing methods: Cost plus pricing methods / full cost pricing, conversion cost pricing, differential cost pricing; variable cost pricing, direct cost pricing. Derivation of cost of apparel products – woven / knits. CM, CMT cost analysis for various styles. Activity based costing, Cost analysis for various styles of garments. FOB/CIF/C and F pricing of apparels. Personnel management- Human Resource Planning, job analysis, recruitment and selection, Training and development, compensation, performance appraisal, communication, career planning and development, conflict solution, personal audit, organization development, work environment. Industrial psychology. Trade globalization and its effect on Indian apparel industry.

Suggested Readings

1. Carr Harold and Latham Barbara (2008). The Technology of Clothing Manufacture. Blackwell publishing, 4th edn.
2. Chuter. A. J. (1995). Introduction to clothing production management. Blackwell publishing, 2nd edn.
3. Eberle, Hannelore (2008). Clothing technology: from Fibre to Fashion. Verlag Europa-Lehrmittel, Nourney, Vollmer GmbH and Co., 5th edn.
4. Gerry Cooklin (2006). Introduction to Clothing Manufacturers. Blackwell publishing, 2nd Edn.
5. Grace I. Kunz, Ruth E. Glock (2005). Apparel Manufacturing: Sewn Product Analysis. Pearson/ Prentice Hall, New Jersey, 4th edn.
6. John M and Nance Vich (1998). Human Resource management. Irvin/McGraw Hill.
7. Jones Richard (2006). The Apparel Industry. Wiley-Blackwell, 2nd edn, 2006.
8. Kunz Grace I (2011). Going Global: The Textile and Apparel Industry. Fairchild Books, 2nd edn.
9. Leap L and Crino M D (1989). Personal/Human resource management. Macmillan Publishing.
10. Monappa, Arun, Saiyadin S Mirza. (1991). Personal Management. McGraw hill publishing company.
11. Paula J and Myers-Mc Devitt (2010). Apparel Production Management and the Technical Package. Bloomsbury Academic.
12. Shaeffer Claire (2001). Sewing for the Apparel Industry.Prentice-Hall, 1st Edition.
13. Thomas Anna Gawb (1994). The Art of Sewing. UBS Publishers Distributers ltd.
14. https://www.onlineclothingstudy.com/2018/11/different-departments-in-garment.html
15. https://www.techtarget.com/searchhrsoftware/definition/human-resource-management-HRM#:~

16. https://en.wikipedia.org/wiki/Human_resource_management.
17. News paper: Economic Times.
18. E- course: Hayavadana, C.H. Sc., TXAD 412, Apparel Industry Management 3 (3+0), ANGRAU, Hyderabad.

Agro Textiles 2 (1+1)

Objectives

This course will enable students to:

1. Impart knowledge about various agrotextiles, its uses, application fields and advantages
2. Acquaint the students with the techniques involve in manufacturing of different agro-textiles and study the recent development in the field
3. Enable the students to Identify the properties required for agro textiles

Theory

Introduction to Agrotextiles. History, significance, Fibres used, Fabric Construction details, Properties required, production techniques and Advantages. Substantial Role of Agro-Textiles in Agricultural Applications. Meaning, need, application, materials used, types, characteristics, advantages and constraints of different agro-textiles: Sun screen, Bird protection nets, Plant nets, Ground cover, Wind protectors, Windshield, Root ball net, Insect meshes, Turf protection net, mulch mats, monofil nets, cold and frost controls, covering pallets, anti hail stone nets, harvesting nets, packing materials. Agro textiles for Animal husbandry, Fishing and aquaculture nets. Meaning, need, application, materials used, types, characteristics, advantages and constraints of different agro textiles used in Animal husbandry, Fishing and aquaculture. Marketing strategy Significance of agro-textiles in technical textiles industries, Past, present and future prospects, techno-economics of agro-tech.

Practical

Introduction to all types of agrotextiles – showcasing the fabric samples and their applications. Survey for agro textiles in the market and collection of swatches. Identification of swatches, preparation of agro textile portfolio. Assessment of the functional property of agro textiles. Mini project (group activity)- Designing agro-textiles for specific functional performance.

Suggested Readings

1. www.textileworld.com/textile-world/.../agrotextiles-a-growing-field/
2. textilelearner.blogspot.com/2012/02/agro-textiles-general-property.htm
3. http://www.textilemedia.com/technical-textiles/new-textile-materials/agrotextiles/9.http://www.textileworld.com/Issues/2005/September/NonwovensTechnical_Textiles/Agrotextiles-A_Growing_Field
4. http://www.fibre2fashion.com/industry-article/textile-industry-articles/agrotextiles-a-rising-wave
5. http://www.indiantextilejournal.com/articles
6. Hira Manisha A. Agro-textile Products and Their Usage. Sasmira, Mumbai

7. Handbook of Agro textiles: www.technotex.gov.in
8. http://www.technicaltextile.net/articles/agro-textiles/detail.aspx7article icl=5386
9. Horrocks AR and Anand SC. (2000) Handbook of Technical Textiles. Woodhead Publication Ltd, Cambridge.

Recent Advances in Textiles 2 (2+0)

Objectives

1. To develop an understanding among student about recent trends in fibres, fabrics, chemical processing and bio-finishes
2. To impart knowledge about smart textiles, wearable clothing, use of microfibres, nano fibres and its application, microencapsulation, nanotechnology, technical textiles and application areas

Theory

Recent researches in production and manufacture of textile fibers, yarns and fabrics. Bio-finishes and processing of natural textiles and their conversion into clothing. Developments in the field of functional textiles, technical textiles and its application areas. Use of special techniques in textile processing. Thrust areas of contemporary research and future projections.

Suggested Readings

1. Journals of Apparels and Textiles
2. Online researches available on CERA and other web portals.

Resource Management and Consumer Science

Residential and Commercial Space Design 3 (2+1)

Objectives

By the end of the course the students will be able to:

1. Gain knowledge in designing space for family living
2. Get exposure to design and decorate residential spaces
3. Gain managerial skills and handle space efficiently for multiple functions
4. Study building Codes, fire safety and barrier - free designs as essential components of laying out interior space
5. Learn use of presentation boards to assist clients in visualizing the design project

Theory

Residential and commercial buildings: types and characteristics - Factors influencing building design- Approaches to planning residential and commercial spaces - Steps in Design process -Understanding on building bye laws and standards. Design and space organization analysis of independent houses and apartments of different income groups. Estimation of cost of fittings, fixtures, furniture, lighting and materials for residential and commercial interiors. Study of commercial interiors for business establishments, hotels/ restaurants, hospitals, educational buildings, public service buildings - Specifications writing, tenders and contracts.

Practical

Develop conceptual drawings and floor plans for various income groups. Develop layouts of furniture, lighting, electrical and plumbing for various income groups. Practical applications of design and space organization of apartments and flats and analysis. Cost estimation for designing interiors of various income groups. Planning of ergonomic work layout for a small project (1000 sq. ft.). Planning of ergonomic work layout for hills areas and commercial areas. Evolving interior decoration details with material sample for the small project. Evolving interior decoration details with material sample for hills areas. Evolving interior decoration details with material sample for the large commercial area. Presentation of the detailed work done for small projects. Presentation of the detailed work done for hill areas. Presentation of the detailed work done for large commercial projects.

Suggested Readings

1. Bonda P and Sonsnowchik K. 2007. Sustainable Commercial Interiors. John Wiley and Sons Publication.
2. Crafts. 2004. The office – Designing for Success. Images Publication
3. Francis D. 1997. The New Office. Conran Octopus Publication
4. Harmon S and Kennon K. The Codes guidebook for Interiors. 5th edn. John Wiley and Sons Publication.
5. James Ambrose. 1997. Building Construction – Interior systems. Published by S.K. Jain for CBS Publishers and Distributors, New Delhi.
6. Joseph De Chiara, Julius Panero and Martin Zelnik. 1991. Time - Saver Standards in Interior Design and Space Planning.
7. Jones Lynn M and Allen Phyllis S. 2009. Beginnings of Interior Environments. 10th Edition. Pearson Education Inc., New Jersey.
8. Karlen Mark. 2009. Space Planning Basics. Space Planning Basics. Third Edition. John Wiley and Sons Inc., New Jersey.
9. Knowles Evelyn and Boehr Kay Millet. 2014. A comprehensive guide for selecting interior finishes. Pearson education, USA
10. Piotrowski C and Rogers E.1999. Designing Commercial Interiors. Second Edition. John Wiley and Sons Publication.
11. Ralph Leibing W. 1999. Architectural Working Drawings. 4th edn. John Wiley and sons, New York.
12. Renuka S and Reddy Mahalakshmi V. 2009. Housing and Space Management. Directorate of Information, and publications of Agriculture (DIPA), ICAR, New Delhi.
13. Sam Kubba. 2003. Space Planning for Commercial and Residential Interiors. McGraw – Hill Professional, New York.

e-books

1. Fundamentals of Building Orientation and Green Building features. 4th edn. October 2015. Published by Indian Railways Institute of Civil Engineering, Pune.
2. Model Building Bye - Laws, 2016. Ministry of Urban Development, Government of India.

3. National Building Code of India 2016. Volume 1. Published by Bureau of Indian Standards, New Delhi.
4. Indian Standard - Recommendations for Basic requirements of Educational Buildings. 2006. Published by the Indian Standards Institute, New Delhi.

Colour and Lighting In Interiors 3 (2+1)

Objectives

This course aims to help students to

1. Acquaint with various aspects of color and lighting
2. Understand the theories and qualities of colour
3. Study uses and applications of different colours
4. Understand various aspects of colour in vision
5. Get awareness about different sources of light and benefits of effective lighting
6. Enrich the students with knowledge about right placement of lighting fixtures
7. Study the amount of light needed for different activities

Theory

Importance of colour and light in interior environment. A brief history of colour as an interior design element; Physics of light - Physiology of vision - Properties of colour - Hue, value and intensity - harmony, mixing and colour interactions. Approaches and theories of colour. Cultural, physical and psychological effects of colour; Types of colour schemes - Related and contrast colour schemes; Factors to consider while choosing colour schemes for buildings; Visual tricks - Use and application of colour in interiors of residential and non - residential buildings. Suitable colour schemes for residential, commercial, public, educational and religious building interiors. Importance and sources of lighting; Cultural and social aspects of lighting; Properties of lighting -Reflection, absorption, transmission and diffusion; Types of lighting - Decorative aspects of lighting -Lighting requirements for household activities; Lighting requirements in commercial buildings. Measurement of light and its units; Types of lamps, their characteristics and suitability to various rooms. Types of lighting based on direction of use, place of use, purpose and portability; Lighting controls - Lighting Luminaires/ fixtures. Factors affecting the quantity of illumination in a room -Method of calculating lighting requirements for various rooms; Lighting for outdoor living and gardens. Colour rendition; Use of colour and lighting in architecture - Use of colour and lighting in problematic areas - disguise and camouflage. Lighting different spaces in the interiors. Important Lighting terms; Importance of Controlling Luminance. Eco - friendly lighting benefits and ideas. Need for quality in the selection of colours and lighting in the built environment.

Practical

Study of types of colour schemes in residential interiors. Study of types of lamps and lighting used in residential interiors. Planning colour schemes for residential interiors. Group discussion on use of colour and lighting in interiors. Study of types of colour schemes in commercial interiors. Study of types of lamps and lighting used in commercial interiors. Presentation on use of colour and lighting in commercial interiors. Suggesting suitable colour schemes for commercial buildings and its cost estimation. Group discussion on suitable colour schemes for residential and commercial

buildings. Suggesting suitable colour schemes for commercial buildings and its cost estimation. Group discussion on suitable colour schemes for residential and commercial buildings. Suggesting suitable lighting fixtures for residential buildings and its cost estimation. Drawings to show the effect of different types of lighting in interior spaces. Lighting calculations for interior spaces using different methods- cavity method and point to point method. Suggesting suitable lighting fixtures for commercial buildings and its cost estimation. Group discussion on suitable lighting fixtures for residential and commercial buildings. Prepare a colour and lighting plan for problematic areas like space below stair case and estimate the cost. Prepare a colour and lighting plan for problematic areas like, irregular shape rooms or narrow areas and estimate the cost. Market survey to understand the available safety and emergency lighting systems and presentation of report.

Suggested Readings

1. Grosslight J (1984) Effective use of daylight and electric lighting in residential and commercial spaces. Practice Hall, New Jersy.
2. Itten J (1970) The Elements of Colour. Van Nostrand Reinhold Company, New York.
3. Nielson K J and Taylor D A (1990) Interiors an Introduction. Wm. C. Brown Publishers. IA, USA.
4. Nissen Lu Ann, Faulkner R and Faulkner S (1994) Inside Today's Home. Harcourt Brace College Publishers, New York.
5. Seetharaman P and Pannu P (2005) Interior Design and Decoration. CBS Publishers and Distributors. New Delhi.
6. Zelanski P and Fisher M P (1999) Colour. Prentice Hall, New Jersey.

Tourism and Hospitality Management 3 (1+2)

Objectives

The course aims to help the students to gain a basic knowledge of:

1. Skills associated with problem solving, creative and critical thinking; related to tourism industry
2. Applying the concepts and skills necessary to achieve guest satisfaction
3. Demonstrating knowledge of multi - cultural perspectives to meet the needs of the guests and employees
4. Leading with the knowledge that the foundation of tourism and hospitality is based on the respect for the host culture with the responsibility to perpetuate unique values, traditions, and practices of that place
5. Demonstrating ability to perform basic and supervisory level job functions in hotel and restaurant careers

Theory

Tourism Management Introduction to Tourism, Growth and development of modern tourism, Tourism in India, Heritage/ Cultural, Pilgrimage Tourism, Medical, Hot Spots and Culinary Tourism -Business and Cruise Tourism - Eco-tourism/ Rural tourism - Emergence of Eco-tourism / Rural tourism - Concept and definitions - Growth and development issues in eco-tourism - Travel Agency

and Tour Operation and logistics (Airlines operation and ticketing. Ships cruise services) business in India, Emerging trends of tourism, Impacts of Tourism, Ethics issues in tourism - Introduction to Hospitality Management. Basic Management Principles: planning, organizing, staffing, leading, controlling with specific reference to hospitality. Hotel hierarchy: GM, departmental heads, supervisors, operational employees Soft Skills in Hospitality; personal development, motivation. Communication techniques and skills, Hostess training Services offered to guests such as food and accommodation services and personal services Front Office management. Maintenance of front office records - housekeeping services - cleaning and linen services, bed making Accommodation Operations - Role of accommodation operations in hospitality. Public areas – maintenance and decoration.

Practical

Study of all the activities of a tourism office and report Planning for a tour - Heritage, Eco, Wildlife, Pilgrimage, medical etc. - Planning for Accommodation operations - Preparation of a tour package -Visit to different tourist spots - Planning layouts of front office of different institutions - Mock sessions on front office handling - Mock sessions on Communication Techniques and Skill - Mock sessions on Handling Complaints and Emergencies - Mock sessions on Handling various types of clients - Practical sessions on Hostess training - Services offered - Practical sessions on housekeeping services - Report writing.

Suggested Readings

1. Dharmarajan, S. and Seth, R. Tourism in India-Trends and Issues,1st edn. HarAnand Publications Pvt. Ltd. New Delhi.
2. Gupta, S. World Tourism in New Millennium, ABD Publishers, Jaipur, First edition.
3. Kamra, K. K and Chand, M. 2006. Basics of Tourism-Theory, Operation and Practice, 1st edn. Kanishka Publishers, New Delhi.
4. Maken, D. Strategies and Planning in Tourism and Industry, 1st edn. Adhyayan Publishers and Distributors, Delhi
5. Puri, M. and Chand, G. 2006. Tourism Management. 1st edn. Pragun Publications, New Delhi.
6. Roday, S., Biwal, A. and Joshi. V. 2009. Tourism Operations and Management, 1st edn. Oxford University press publication, New Delhi.
7. Sharma. R.B. World Tourism in 21st Century, 1st edn. Alfa Publications, New Delhi.

Financial Management and Consumer Behaviour 3 (2+1)

Objectives

1. To develop understanding of concepts of income and expenditure among families
2. To provide skills and techniques requisite to tackle consumer problems and management of finance and consumer education
3. To enhance knowledge on consumer behavior and issues and e-tailing concepts

Theory

Importance of financial management. Income concepts; Circular flow of Income: the wheel of wealth, factors affecting fluctuations in income, depreciation in money value: inflation, deflation, consumer price index. Financial planning - Steps of successful financial planning; Financial spending plan. Budget: types, steps, advantages and disadvantages. Credit and credit instruments. Saving and investment. Taxation. Consumerism and Consumer Protection: Consumer rights and responsibilities, Consumer Protection Act 2019, Other important Govt. Laws/ Acts for protecting consumers. Consumer Courts: Redress mechanism. Consumer Protection Councils. Advertising Standards Council of India. Standards and standardization and legislative measures for regulating quality. Role of Govt. and NGOs for consumer protection and welfare. Consumer issues and challenges. Consumer behaviour: Defining consumer behaviour, meaning and importance of consumer behaviour. Consumer decision making: Determinants and consumer choices, impact of technology on consumer choices and economic well - being, factors affecting consumer behaviour. Social, cultural and group influences on consumer behavior, Individual determinants, motivation and personality on consumer behaviour. Environmental influences on consumer behaviour. E -consumer behaviour: E - marketing/ E - consumerism/ E - business/ E - tailing. Digital marketing: techniques and strategies. Trends in marketing with respect to consumer behaviour.

Practical

Conducting survey on few families to study various sources of family income, drawing income profiles, and studying their methods of handling money income. Planning Budgets for families with different income groups. Exercise on calculation of Consumer Price Index. Preparing educational aids on Consumer Rights and Responsibilities. Exercise on filing a consumer complaint in Consumer Forum. Collecting/ studying fraudulent advertisements on print and electronic media and reporting about them. Collecting different products with Standardization marks. Collecting Product Labels and studying labeling details. Market survey to study Weights and Measures practices by vegetable sellers, cloth sellers, ration shops, petrol pumps, LPG cylinders etc. and making a report. Visit to Consumer Forum. Carryout a short study (may be using google forms) to study Consumer behaviour components in buying any product. Reporting and presentation. Explore problems/ cheating in e -shopping.

Suggested Readings

1. Bhatt R. 2010. Consumer Behaviour. Common Wealth Publishers Pvt. Ltd.
2. Das, S.N. 1973. An Introduction to Economic. Theory Premier Publisher, New Delhi.
3. Dewett, K.K. and Navalur M.H. 2006. Modern Economic Theory. S Chand Publications. New Delhi.
4. Gross, Grandall and Knoll. 1980. Management for Modern Families (3rd Ed.). Prentice – Hall, Inc. Englewood Cliffs, New Jersey.
5. Kaur, Surinder, Lekhi, R.K. and Singh, Joginder. 1997. Consumer Economics. Kalyani Publishers, New Delhi.
6. Khan, Martin. 2011. Consumer Behaviour and Advertising Management. New Age International (P) Limited Publishers.
7. Nickel and Dorsey. 1976. Management in Family Living (4th ed.) Willey Eastern Limited, New Delhi.

8. Rice, Nickel and Tucker. 1976. Management in Family Living (5th ed.). John Wiley and Sons, Inc. New York, London.
9. Sharma S and Kumar D. 2001. Advertising, Planning, Implementation and Control. Mangal Deep Publ.
10. Shukul M and Gandotra V. 2006. Home Management and Family Finance, Dominant Publishers and Distributors New Delhi.
11. Seetharaman P and Sethi M.2001.Consumerism. Strategies and Tactics. CBS.
12. Swanson, Bettye B. 1983. Introduction to Home Management. Macmillan Publishing Co. Inc., New York
13. Waugh, Albert, E. 1987. Principles of Economics. Mc Graw Hill Book Company, Inc. New York.

Workspace and Product Design **3 (1+2)**

Objectives

The course aims to help students in:

1. Developing skills in space designing for different activities
2. Understanding the importance of space designing to avoid work related health hazards.
3. Developing skills in designing workspace for residential, commercial and industrial units
4. Developing skills in design consideration in product development
5. Familiarizing with product design and product manufacturing terminologies
6. Understanding how to use users in product design cycle
7. Evaluating the products in the consumer market from usability perspective

Theory

Body Mechanics; Functional design of workspace - Concept of functional design, centre concept, design and arrangement of different work centers, designing of work surface, storage and work accessories/ appliances; Lighting/ furniture requirements for different activities; Hazards of ill designed workstations; Functional designing of workspace for physically handicapped and elderly population. Design concepts - Design definition, design terminologies (user - centered design, user -friendly design, accessible design, universal design, usability, etc.); Design process; Design sustainability - Ergonomic factors in design, user interface, use of design elements for ease of operation of a product; Quality Control and Standardization of Product, and product certification; Design consideration for accessible products. Work, worker workplace interrelationship.

Practical

Evaluation of existing workstation in a residential product; Understanding the selected consumer products through guidelines given by manufacturers; Evaluation of selected product to find out the ease of operation; Ideation of design concepts.

Suggested Readings

1. Bootheroyd G, Dewhurst P and Knight W. 2002. Product Design for Manufacture and Assembly. CRC Press.

2. Dalela S and Saurabh. 1999. Textbook of Work Study and Ergonomics, Standard Publ.
3. Frey D. 1998. AutoCAD 14. BPB Publ.
4. Galer Ian. 1982. Applied Ergonomics Handbook. Butterworths and Co.
5. Grandgean E. 1978. Ergonomics of the Home. Taylor and Francis.
6. Marcelo M. Soares. 2021. Design Methodology for production designing for Human - centered approach, CRC Press.
7. Marcelo M. Soares. 2021. Handbook of usability and User experience research and case studies, CRC press.
8. Panero J and Zelnik M. 1979. Human Dimension and Interior Space. Whitney Library of Design.
9. Ron H. 2000. Using Auto CAD 2000. Special Ed. Prentice Hall of India.
10. Sharma DD. 2000. Total Quality Management. Sultan Chand and Sons.
11. Singh S. 2007. Ergonomics Interventions for Health and Productivity. Himanshu Publ
12. Waldemar Karwowski, Ann Szopa, Marcelo M. Soares. 2021. Standards and guidelines in Human factors and Ergonomics, CRC press

Human Development and Family Studies

Developmental Challenges in Children 3 (2+1)

Specific Objectives

1. To be able to identify children with developmental challenges
2. To develop a positive attitude among people towards the developmentally challenged
3. To create awareness of mainstreaming
4. To understand the rights of the developmentally challenged child
5. To impart knowledge on intervention strategies
6. To create awareness among people regarding the various welfare services available for those with developmental challenges

Theory

Defining Developmental Challenges- classification and types. General provisions for persons with developmental challenges, Identification of 'At Risk' children, Special needs and special education: Definition of special needs of children and special education, terminologies for children with special needs, history of special education, current trends and issues in special education, Need and objectives of Special Education, The NEP/NPE (2020) and the program of action relating to special education. Legislation and litigations of special education. Labelling- definition and its effects. Mainstreaming- definition, models of mainstreaming, problems in implementing mainstreaming, effect of mainstreaming on children with special needs. Intellectual disabilities- definition, classification, Identification, Diagnosis, Prevalence, causes and measurement / Assessment of Intellectually challenged, their psychological and behavioral characteristics and educational considerations for Intellectually challenged children, Instructional methodology, managing child in school. Learning disabilities- definition, types, prevalence, causes and measurement of LD, psychological and behavioural characteristics of LD children, educational considerations for LD

children, managing child in school. Communication disorders- definition, speech production, speech disorders, language disorders, multiple disorders (disorders associated with cerebral palsy, hearing impairment, cleft palate or cleft lip, MR, ED and LD), prevalence, causes of CD, identification, psychological and behavioural characteristics of CD children, educational considerations for CD children, managing child in school. Auditory impairment- definition, anatomy and physiology of ear, classification, prevalence, causes, measurement of AI children, psychological and behavioural characteristics of AI children, educational considerations for AI children, managing child in school. Visual impairment - anatomy and physiology of eye, definition, classification, prevalence, Identification, causes and measurement of VI children, psychological and behavioural characteristics of VI children, educational considerations for VI children, aids and equipment, managing child in school. Physically challenged- definition, classification, prevalence, musculoskeletal conditions, congenital malformations, accidents, diseases and other conditions, psychological and behavioural characteristics of P challenged children, educational considerations for PC children, managing child in school. Neurological impairments - Convulsive disorder- causes, types, diagnosis, treatment, characteristics, managing child in school. Cerebral palsy- Definition, types, causes, Diagnosis, Treatment and managerial provisions, educational provisions for the children with cerebral palsy. Autism- definition, diagnosis and identification, assessment, causes, characteristics. Emotional disorders- definition, classification, prevalence, causes and identification of ED, psychological and behavioural characteristics of ED children, educational considerations for ED children, managing child in school. Giftedness- definition, prevalence, origins of giftedness, screening and identification of giftedness, psychological and behavioural characteristics of gifted children, attitudes towards gifted children, educational considerations for gifted children, managing child in school. Rights and provisions for children with special needs in India. Constitutional provisions and protection for differently abled children in India. General provisions for persons with developmental challenges, Intervention- concept, methods, steps and process, intervention strategies for children with special needs, role of professionals, need and importance of family centred intervention – Family counselling for children with special needs.

Practical

Observational visits to institutes/case studies of children with special needs. Identification of children with special needs in the local community. Developing educational material on identification of children with special needs, organizing educational programmes for families of children with special needs, planning, recreational and vocational activities for children with special needs; Presentation of case study reports.

Suggested Readings

1. Achenbach, T.M. (1982). Developmental Psychopathology. 2nd edn. John Wiley, New York.
2. Berdine, W.H. and Blackhurst, A.E. (1985). An Introduction to Special Education. 2nd edn. Harper Collins, Lexington.
3. Hallahan, D.P. and Kauffman, J.M. (1991). Introduction to exceptional children. 5th edn. Allyn and Bacon, Boston.
4. Hegarty, S. (2002). Education and children with special need. Sage publication. New Delhi.
5. Kar, C. (2008). Exceptional Children: Their Psychology and Education. Sterling Publishers Pvt. Ltd. New Delhi.

6. Loring, J. and Burn, G. (Eds). (1978). Integration of handicapped children in society. Routledge and Kegan Paul, London.
7. Mangal, S. K. Educating Exceptional children-An Introduction to Special education.
8. Prasad, J. and Prakash, R. (1996). Education of Handicapped Children, Problems and Solution. Kanishka publication distribution. New Delhi.
9. Philip, M. and Duckworth, D. (1985). Children with Disabilities and their Families: A review of research. Berks: NFER-Nelson Publishing Co., Windsor.
10. Rozario, J. and Karanth, P. (2003). Learning Disability in India. Sage publication. New Delhi.
11. Singh, A. N. (2003). Enabling the Differently Able: Concepts, Education and Community. Sipra publications, Delhi.
12. Taylor, R.L. and Sternberg, L. Exceptional Children: Integrating Research and Teaching. Springer Study Edition, Springer- Verlag. New York.
13. Tinberger, N. and Tinberger, E.A. (1983). Autistic Children: New Hope for a Cure. Allen and Unwin, London.
14. Werner, D. (1994). Disabled Village Children (Indian edition). Voluntary Health Association of India, New Delhi.

Methods and Materials for Teaching Young Children 3 (1+2)

Objectives

1. Identification of use of different creative materials
2. Exploring different methods for use in the classroom
3. Hands on practice of use of methods and materials
4. Developing resource files on methods and materials for regular use in classrooms

Theory

Orientation on different methods and materials used for teaching young children. - Children's literature- definition, importance and different kinds of literature appropriate for young children - Story telling- definition, types and different techniques for effective storytelling; teacher led story telling methods; Children led story telling methods; role play, singing, using masks etc - Creativity- definition, types, characteristics of creative children - Art and art activities (Painting, drawing, paper craft, collage, modelling, printing and sand art) - Use of raw material, natural material in art and creative work - Creative expression in young children- identification of different types of creative expressions, developing rhymes with music and movements appropriate for young children - Puppets - importance and types (finger, stick, sting, glove and shadow) in child development - Building blocks and their innovative uses - Importance of music and use of music and musical instruments for young children - Innovative Class room arrangements; Bringing nature into the classroom - Guest appearances in classroom - Use of films, documentaries in teaching concepts - Resource file, its importance and usefulness - Educating parents/teachers on use of learning materials for young children

Practical

Use different methods and indigenous /creative materials for teaching young children - Survey and reporting of available different kinds of literature appropriate for infancy through early

childhood - Reporting on different kinds of literature appropriate for infants and preschool children - Visit to Organizations and children's libraries for development of literature - Practicing different techniques of storytelling and analyzing effectiveness - Developing stories appropriate for young children - Developing stories on Folk tale - Developing moral stories - Developing stories related to epics - Identification of different types of creative expressions in young children - Planning and implementing activities to promote creative expressions among young children through a variety of media (Rhymes, drama, role play and story) - Preparation of art file appropriate for young children - Preparation of paper craft - Preparation of Painting file - Preparation of drawing file - Preparation of murals - Preparation of printing and collage - Preparation of resource books teaching daily life concepts - Preparation of different types of puppets and Scripting for short puppet show and creative dramas - Preparation of finger/stick puppets - Preparation of string/ hand puppets - Preparation of shadow puppets - Preparation of collage, murals and models appropriate for infancy through early childhood - Art activities (Painting, tearing, cutting, pasting and collage, murals, modelling, printing blocks, sand and mud, water) - Practicing musical activities: use of music, voice modulation and sound effects - Preparation of resource file and teaching materials for young children - Evaluation of materials for teaching young children- Organizing an exhibition for parents of young children.

Suggested Readings

1. Blackie, Pamela. (1972), Drama. Macmillan, London.
2. Contractor, M. (1984), Creative Drama and Puppetry in Education. National Book Trust of India, Delhi.
3. Currell, D. (1985), The Complete Book of Puppet. A and C. Black, London.
4. Garretson, R. (1966), Music in Childhood Education. Meredith Publishing Company, New York.
5. Hendrick, J. (1980), Total Learning for the Whole Child. The C V Mosby, St. Louis.
6. Kaul, V. (1991), Early Childhood Education Programme. NCERT, New Delhi.
7. Kaul, V. and Bhatnagar, R. (1992), Early Childhood Education: A Trainer's Handbook, NCERT, New Delhi.
8. Lacper, S., Witherspoon, R. and Day, B. (1984), Good Schools for Young Children. Mac Millan, New York.
9. Maxim, G. (1985), The Very Young. Wadsworth Publishing Company, Belmount, California.
10. Murlidharan, R. and Asthana, S. (1991), Stimulation Activities for Young Children. NCERT, New Delhi.
11. Robinson, H. (1983), Exploring teaching. Allyn and Bacon, London.
12. Swaminathan, M. (1984), Play Activities for Young Children, UNICEF, New Delhi

Computer Application in ECCE 3 (1+2)

Objectives

1. To enable students to equip 21cenutary skills, abilities that have been identified as being required for success
2. To strengthen students with Digital literacy skills: information literacy, media literacy, Information and communication technologies (ICT) literacy

Theory

Introduction to computer - Windows operating system - MS Word -Power point program -Excel Programme-Data management skills - Internet usage -Web based resources -ICT tools in classroom teaching –Introduction to multimedia -Basics of Graphic Design - Use of Digital technology -Definition of Digital images -Colour theory and basics -Digital imaging in multimedia and animation - Use of Design Elements in Digital Layouts -Scanning / Capturing Images - Masking and Colour adjustments -Editing Images, Cutting and Morphing - Work in different media, such as drawing, collage, and painting -Working with visual images -3D Modeling - 3D Shading – Animation - Making videos with animation -Editing videos -Software available for preschool program - Integrating technology into ECCE classroom: Issues and challenges - Developing and maintaining digital records for ECCE - Using Digital Media to Support Early Learning - Digital Tools for Learning, Creating, and Thinking: Developmentally Appropriate Strategies for Early Childhood Educators - Effects of using computer applications for teaching and learning

Practical

Create word document - Prepare a broacher to advertise preschool program -Power point presentation on parent education program -Design Flyer for conducting workshop- Prepare a sample record of student information - Prepare a sample record of stock - Prepare sample record of fee payment particular - Prepare evaluation report of student -Prepare evaluation report of teachers - Google form for feedback -Create an animated story - Digital lesson on alphabet - Develop a video on any concept - You tube rhymes - 3D modelling on animals - Graphics for numerical skill development in children - Create a story of animals with visual effect -Develop a simple science experiment on a digital platform - Animated cartoons - Develop two animated characters for the concept introduction.

Suggested Readings

1. Adekemi A. A. (2001), Introduction to Computer Education. An Unpublished Monograph, Obafemi Awolowo University, Ile-Ife.
2. Ajibade A (2006). Effects of Interactive Instructional Compact Disc Package on the Performance of English Language Learners in Schools of Science in Osun State. Unpublished Ph. D. Dissertation, Faculty of Education, Obafemi Awolowo University, Ile-Ife.
3. Amani M. Albarkati, Saudi Arabia (2016). The Application of Computer in Education System and its Significance to Teaching and Learning, International Journal of Computer Applications (0975 – 8887) Volume 134 – No.9, January 2016.
4. Chible, Hussein. (2021). Computer Applications.
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6. Mahin, L. (2004). PowerPoint pedagogy. Business Communication Quarterly, 67, 219-222.
7. Paje, Y. M., Rogayan, D. V., and Dantic, M. J. P. (2021). Teachers' utilization of computer-based technology in science instruction. International Journal of Technology in Education and Science (IJTES), 5(3), 427-446. https://doi.org/10.46328/ijtes.261
8. Software for Preschool program that the department has to purchase

9. https://sourceforge.net/software/child-care/india/
10. https://educase.io/daycare-management-software/
11. https://play.google.com/store/apps/details?id=preschool.erpsoftware.app and hl=en and gl=US EduSys Pre-school ERP -Childcare Play-school Management Software

(Foot notes: The course computer application in EECE requires advanced skills in computer graphics, animation and digital techniques. As the HDFS faculty may not be equipped with computer skills needed in dealing with the course, an advanced training program in computer skills is required for the teachers. It is also required to hire a computer specialist to teach course content at least for one semester or till the faculty gets trained)

Guidance and Counselling 3 (2+1)

Objectives

1. To orient about different techniques of counselling and guidance for different problems /areas
2. To learn about essential skills of family counselling and child guidance
3. To understand various needs of children and families for counselling and guidance services

Theory

Guidance - concept, need, nature, scope, goals and essentials, Characteristics, Principles and assumptions, Techniques, challenges, History; Guidance services in India; Foundations / Bases for Guidance – Philosophical, Psychological, Socio-cultural; Types /Areas of Guidance -Educational Guidance, Vocational Guidance, Personal – Social Guidance/ Group Guidance, Guiding children-Infants and Toddlers, pre-schoolers, school age. Guidance for adolescents – Career and Vocational guidance.

Counselling - Meaning, Purpose, Goals and objectives, Scope, History, Characteristics, Principles, Levels, Classification; Thrust areas of Counselling; Life Span stages and counselling; Functions of counselling; Different types of counselling Techniques; Theories to counselling – Psychoanalytic theory, Roger's Self theory, Trait theory, Field theory, choice theory, behavioural learning theory, Family systems theory; Approaches to counselling- Psychoanalytical approach-psychotherapy/ psychoanalytic therapy, Transactional Analysis therapy; Behaviouristic approach-Behaviour therapy, Rational emotive behaviour therapy (REBT), Cognitive Behaviour Therapy (CBT); Humanistic approach- - Client centered therapy, Gestalt therapy, Existential therapy and other Contemporary therapies- Adlerian therapy, Reality therapy, Family systems therapy, Feminist therapy.

Counselling- Process, Aspects, Dimensions, Stages; Effective strategies in counselling, Counselling skills – Meaning, Categories; Premarital counselling - concept, process, techniques, Marital Counselling - Couple counselling process and techniques; Family Counselling - Concept and its evolution, aims and objectives, types, process; Counselling for Special groups- delinquents, women, weaker sections, drug addicts, physically handicapped, emotionally handicapped, reluctant clients, surrogacy; Tools and techniques of Assessment in counselling – standardised and non standardised techniques; Modern / current trends in counselling; Roles, Characteristics or Qualities of a Counsellor; Limitations of Counselling; Ethical issues and Dilemmas in Counselling.

Practical

Visit to Child Guidance institutions – CGC - Visit to Family guidance and Counselling institutions – Family Court/ Women protection Cell/ Domestic Violence cell - Visit to a career or vocational counselling centre - Review on various aspects of guidance and counselling - Studying problems and issues in children / adolescents(Educational, psycho-social, emotional and personality related) - Demonstration on techniques of guidance by the trained professional-Simulation exercises on guidance for children/ adolescents Developing guidance program for the identified children/ adolescents - Executing guidance program on the identified children/adolescents -Presenting reports on guidance program conducted - Identifying families with problems and conducting case studies - Demonstration on counselling techniques by the certified counsellor - Simulation exercises on counselling sessions - Developing counselling sessions for the identified families – Play therapy/ REBT/CBT - Executing counselling session - Presenting reports on counselling session conducted-. Developing Resource Files on Guidance and counselling services for families.

Suggested Readings

1. Asha K. K. (2008). Guidance and Counseling. Dorling Kindersly (India) Pvt. Ltd, New Delhi. Pp 142-144.
2. Chauhan, S.S. (2001). Principles and Techniques of Counseling. Vikas publishing house Pvt. Ltd. New Delhi. Pp 17-19.
3. Cooper, S. (2005). Counseling, Inception, Implementation and Evaluation. Infinity Books, New Delhi.
4. Corney, G. 2017. Counselling and psychotherapy, 10th Edition, CENGAGE learning.
5. Crow, L. D., and Crow, A. (2008). An introduction to guidance. Surjeet Publications, Delhi.
6. Elizabeth, R.W and Peterson, L. E. (2000). The Counseling Process, 6th edn. Printice Hall Inc. U.S.A. Pp 52-63.
7. Geldard, K. and Geldard, D. (2002). Counseling Children - A Practical Introduction. Sage Publications, New Delhi. Pp-3-17.
8. Geldard, K. and Geldard, D. (2002). Counseling Adolescents, Sage Publications., New Delhi.
9. Hildebrand. V. (1985). Guiding Young Children. 4th edn, Mac. Millan Publishing Company, New York Srivastava, K.K. (2003). Principles of Guidance and Counseling. Kanishka Publishers, New Delhi. Pp 1-14.
10. Indira, M. (2000). Guidance and Counseling. Authors Press, New Delhi. Pp 1-10.
11. Jones, R.N. (2000). Introduction to Counseling skills. Sage Publications, New Delhi.
12. Nayak, A.K. (2002). Guidance and counseling. APH Publishing corporation, New Delhi.
13. Narayana Rao, S. (1997). Counseling and Guidance. New Delhi: Tata McGraw-Hill Publishing company Ltd. Pp 226-227.
14. Richard, N. J. (2003). Basic counseling Skills. A Helper's manual, Sage south Asia, Pp141- 146.
15. Sharma, R.N and Sharma R. (2004). Guidance and Counseling in India. Atlantic Publishers and Distributors, New Delhi.
16. Vasantha, R. P. (2001). Counseling Psychology. Authors Press, New Delhi, Pp 1-8.
17. Untitled-4 (drbrambedkarcollege.ac.in)

18. Untitled-4 (egyankosh.ac.in)
19. https://www.researchgate.net/publication/325844296_COUNSELING_APPROACHES

Parent Education and Community Welfare programmes **3(2+1)**

Objectives

1. To develop skills and build confidence to educate the parents
2. To enhance skills in developing intervention programmes for different vulnerable/ disadvantaged groups of the community
3. To facilitate the students to work directly for the welfare of local community

Theory

Meaning, Need and Importance of Parent education and Community Welfare. Theories of Community education and its relevance to today's community. Social role valorization theory. Understanding recent issues and challenges of parent education and community welfare. Studying various methods of parent education. Wisconsin's components of community education. Need assessment – its importance, need assessment of parents, and vulnerable groups of the community. program planning and implementation, methodology for parent and community education. National (Govt. and Non govt.) Community welfare programmes- Child and family welfare programmes, constitutional provisions for children, act and legislation relating to protection and welfare of children, act for developmentally challenged, legislations pertaining to parents, women, youth, other gender and elderly. Appraisal of existing welfare programmes and their utility in the community. Ongoing income generating policies and programmes, gender mainstreaming programmes and policies, reservations, Concessions and special facilities of Government of India for vulnerable groups of the community related to health, education, employment, industries and agriculture. International, national and regional policies and programmes (Govt. and Non govt.) for vulnerable groups, family and community. Identification of organizational structure/implementing agencies at different levels. Role of NGO's in community development. Corporate social responsibilities - meaning, role of government in corporate sector and role of the institution (Corporate) in community development.

Practical

Visits to various government, non-government organizations and corporate sectors working for the welfare of the parents, children and community. Finding out role and challenges. Report presentation. Visit to local community to conduct parent and community needs assessment, identify vulnerable parents, families with problems and to conduct case studies, report presentation, Identification of areas and issues for parent education, developing parent education programmes – planning, preparation (creating WhatsApp group, making online flyer) conducting, and evaluating parent education programmes. Report presentation. Awareness/capacity building Programmes with the help of change agent of community development/ organizations (Anganwadi worker, Asha worker, Mohila Shakti Kendra, KVK, FPC, ATMA, APART etc.) to orient community people to the procedure for obtaining different government/ non-government services (how, where, when, whom to apply). Orientation to the use of social platforms. Report presentation. Observation of / participation in community development programmes (Gaon Sobha, health camp etc.) Find out the missing link and develop a road map for a specific community (tribal areas, tea garden areas,

slum areas etc.) for overall development and establishing linkages with different Government/Non-government agencies for welfare of that specific community. Report presentation.

Suggested Readings

1. Boraian, P.M (2008). Employment of rural women. Concept publishing company. New Delhi.
2. Cempbell, D. (2003). Group parent education: Promoting parents learning and support. Sage publication.
3. Epstein, L.J. (2010). School, family and community Partnership: Preparing educators and Improving School, Westview press.
4. Marasimhan, S. (2001). Employment of women. Sage publication. New Delhi.
5. NIPCCD. (1994). Child in India: A statistical profile. NIPCCD, New Delhi.
6. Randhawa, M.S. (1991). The Rural and urban aged. National Book Organization, Unit IX, New Delhi.
7. Saraswathi, S. (1991). Youth in India. ICSSR, Govt. of India, New Delhi.
8. Tett, L. (2006). Community education: Lifelong learning and social inclusion (Policy and practice in education). Dunedin Academic Press.
9. TISS (1994). Enhancing the role of family as agency for social and economic development. TISS Bombay. Vol. II, Part II.
10. UNICEF. (1990). Children and women in India: A situation analysis. Unit VI, VII.

Extension Education and Communication Management

Extension program Management 3 (1+2)

Objectives

1. To understand the importance of extension program and program planning
2. To impart knowledge regarding monitoring and evaluation of extension programs
3. To acquire skills in collecting village information using PRA tools
4. To gain practical experience in developing schedules and collecting information in rural areas
5. To develop practical experience in planning, implementing and evaluating small need based program

Theory

Extension program: meaning; definition; objectives and characteristics. Extension program planning: meaning; concept; objectives; Principles. Steps in extension program planning. Professional abilities needed by planners and criteria for program planning. program implementation: environment and rapport building; role of local leaders; local bodies. Organizations and extension agencies in program implementation. Participatory Rural Appraisal (PRA) tools and techniques: Transect walk, seasonal calendar, Venn diagram, daily routine charts. Participatory Rural Appraisal (PRA) tools and techniques: flow diagram, social mapping, matrix ranking. Steps in program implementation and constraints in implementation of programs at grass root level. Monitoring and

evaluation of extension program: meaning; definition, concept and types. Pros and Cons of few national level extension program.

Practical

Visit to village to identify key informants and establishing rapport. Visit to village to identify rural institutions. Identifying needs and problems of the village with the help of questionnaire. Different PRA tools and its application for data collection: Transect walk, seasonal calendar, Venn diagram, daily routine charts. Participatory Rural Appraisal (PRA) tools and techniques: flow diagram, social mapping, matrix ranking. Development of schedule for collecting baseline information of village. Conducting village and household survey: Socio-economic survey, nutritional status. Conducting village and household survey: Agricultural problems use of Government schemes/programs. Development of need assessment schedule. Collection of data through the developed schedules. Conduct of need assessment. Analysis of data. Preparation of survey reports. Planning a small need-based program. Developing a detailed plan of work for the need based program. Implementation of the need-based program. Evaluation of the need based program implemented. Documentation and presentation of program findings.

Suggested Readings

1. Dahama, O.P. and Bhatnagar, O.P. 2003. Education and Communication for Development. Oxford IBH, New Delhi.
2. Govind, Santha, Tamilselvi, G. and Meenambigai, J. 2013. Extension Education and Rural Development. Agrobios (India), Jodhpur.
3. Gupta, Debabrata Das Gupta. 2011. Extension Education: Core contents and emerging areas. Agrobios (India), Jodhpur.
4. Ray, G.L. 2004. Extension Communication and Management. Kalyani Publishers, New Delhi.
5. Reddy, A.A 2001. Extension Education. Sri Lakshmi Press, Baptala.
6. Sandhu, A.S. 2003. Extension program Planning. Oxford IBH Publishing, New Delhi.
7. Supe, S.V. 2011. Integrated Extension Education. Agrotech Publishing Academy, Udaipur.
8. Verma, V., Verma, S., and Rani, E. (2019). Chapter-1 Programme Planning and Evaluation. Multidisciplinary, 1.

Extension Training Management 3 (1+2)

Objectives

1. To develop understanding about process of training
2. To develop skills in use of different training methods
3. To develop competence in designing, implementation and evaluation of training program

Theory

Training -concept and importance. Types of training: Extension trainings. Online and blended training. Phases of training and its management. Qualities of a good trainer. Adult learning, Characteristics of adult learner. Principles of adult learning. Facilitation skills in training. Identification of training needs. Training methods - Lecture, demonstration, Field trip, Group

discussion, case study, role play, T-group training, games, practice clinics, small group task. Steps of designing training program. Training evaluation – meaning, importance, indicators and methods. Problems in training. Important training institutions in India for extension functionaries, farmers and entrepreneurs.

Practical

Visit to training institutes. Hands on experience on training methods – Lecture/Lecturette. Hands on experience on training methods –Demonstration. Hands on experience on training methods –Case study. Hands on experience on training methods – Role Play. Hands on experience on training methods –Games. Hands on experience – Identifying training needs and needs analysis. Formulation of training objectives. Familiarization with different steps of training. Familiarization with ice-breaking session. Familiarization with online and blended training. Familiarization with monitoring and evaluation tools. Checklist for planning training program. Planning of a training program according to mode of training. Procurement of training material and all preparation. Execution of training program. Evaluation of training program. Preparation and presentation of report.

Suggested Readings

1. Lynton, R. and Pareek, U. 1991. Training for development, Vistar Publ., New Delhi
2. Singh, R. P. 2000. Management of Training Programmes. Anmol Publications Pvt. Ltd. New Delhi - 110002 (India).
3. Singh, R. P, Jhamtani, A. and Singh, P. 1996. Training Management- A Handbook, Jain brothers, 16/873, East Park road, Karol Bagh, New Delhi.

Advertising and Social Marketing 3(1+2)

Objectives

1. To build competence in designing digital social advertisements
2. To capacitate students in developing and implementing social marketing program

Theory

Evolution and history of advertising, relevance of advertising in marketing. Role of advertising agency. Types of advertising- Traditional versus digital advertising, commercial versus social advertising. Various media for advertising. Advertising writing process: Steps for writing effective advertisement. Laws and ethics in advertising. Steps to create advertising strategy for marketing. Different types of advertising strategies. Social marketing- concept, need and philosophy, difference between commercial and social marketing.

Principles and importance of social marketing in development. Marketing mix of social marketing. Models of social marketing. Role and strategies for digital marketing in community development. Social marketing process: Assessment and analysis of the problems. Planning for social marketing strategy based on the identified problems. Execution of social marketing program, Planning for publicity campaign, Execution of publicity campaign. Evaluation of program and reporting.

Practical

Visit to advertising agency and report writing. Designing social advertisements for newspaper. Designing social advertisements for radio. Designing social advertisements for television. Designing social advertisements for poster. Designing social advertisements for hoardings and wall paintings. Designing digital advertisement on social issues for social platforms like whatsapp and facebook. Analysis of the situation to find out the social problems in a community: collect information through secondary sources like newspapers, government documents etc. Focus group discussions with groups/ community to identify social problems and analyzing the situation.

Scanning social market situations-opportunities and constraints. Assessment and analysis of the problems. Preparation of report on collected information. Planning for social marketing strategy based on the identified problems: purpose, target audiences, objectives and goals, marketing mix strategies (4Ps), evaluation, budget, and implementation plans. Designing and pricing social products. Execution of social marketing program using Seven step model of social marketing: Pre knowledge test at field level (selected village). Rally on selected social issue at selected village. Skill training on selected problem. Field trip to relevant stakeholder (SAU/ State departments/ Entrepreneurs/ SHGs). Post knowledge test at field level (selected village). Evaluation of social marketing program. Report writing and oral presentations and discussions based on observations and experiences gained in social marketing program.

Suggested Readings

1. Bhasin H. (12 October 2021) Advertising Strategy in Marketing – Definition and Types Retrieved from https://www.marketing91.com/advertising-strategy/
2. Indeed, editorial team (21 December 2021) How to write an effective advertisement: a complete guide. Retrieved from https://in.indeed.com/career-advice/career-development/how-to-write-an-effective-advertisement
3. Kotler P and Roberto E L (1989) Social marketing: strategies for changing public behavior. The free press, New York.
4. Manoff R K (1985) Social marketing: New imperative for Public Health. Praeger, New York

Public Relations and Communication Management 3 (1+2)

Objectives

1. To provide knowledge about public relations and imparting skills in designing and preparing public relations tools
2. To equip students in planning and executing public relations program
3. To provide knowledge and capacitate students in effectively using communication skills and communication management

Theory

Public relation - Concept, related terms and evolution, role of government institutions in maintain public relations. Process of public relation and publics in public relation. Principles of Public relation. Public relation tools. Public relation models. Laws and ethics of PR- Law of Defamation, Law of invasion of privacy, Copyright act, Trademark, Protection of Civil rights act,

Consumer protection act, RTI etc. Communication skills: Reading; writing; speaking; listening; soft skills. Public speaking: Characteristics, techniques, importance. Modes of delivery in public speaking, check list, need and purpose of public speaking. Communication techniques and communication network. Communication efficiency and effectiveness: factors affecting, communication fidelity and source creditability. Message distortion- factors affecting and types of message distortion.

Practical

Visit to public relation office under government sector for analyzing their public relations activities. Visit to non-government institutions for analyzing their public relations activities. Visit to university PRO office for analyzing their public relation activities. Design Flyer for establishing public relations of your organization. Design brochure for establishing public relations of your organization. Design newsletter for maintaining public relations of your organization. Plan a public relation strategy for popularizing new technology developed by your organization. Writing different types of press releases. Writing feature article.

Prepare a consumer survey to know about preferences and attitude of your clientele regarding new technology. Prepare presentation for popularizing new technology among your clientele and show it to them, use public relations tools for it. Gather data on prepared consumer survey and analyze it. Prepare feedback form and get it filled from clientele. Learning activities to assess and learn listening skills. Learning experiences for improving reading skills with an emphasis on building vocabulary and correct use of grammar. Writing report. Simulation games in communication distortion. Exercise on informative speaking. Exercise on persuasive speaking. Exercise on entertaining speaking. Exercise on impromptu speaking. Exercise on extempore speaking. Exercise on memorize speaking. Exercise on manuscript speaking.

Suggested Readings

1. Chandrakandan K, Karthikeyan C, Venkatesan C and Balaji Babu C (2002) Public Relations. Authorspress global network, Delhi.
2. Loyd H (1970) Public relations. The English universities press ltd., London.
3. Stephenson H (1960) Handbook of Public relations. McGraw hill book co, New York.
4. Sharma Diwakar Public relations: An emerging specialized profession Deep and Deep Publications Pvt. Ltd. New Delhi.

Web Designing 3 (0+3)

Objectives

By the end of the course the students will be able to

1. Get insight of using tools in Adobe Photoshop, Dream Weaver
2. Learn the basics to advanced HTML, Markup language, structural tags and attributes for web construction
3. Hands on experience with working on website for page wise, popup windows, cascading styles, navigational elements
4. Design websites, mobile application screens, advertisements with animations

Practical

Orientation to web designing, software used and familiarization with stock photography, image graphics, vector graphics and tools. Hands on experience with Adobe Photoshop: Pallets, colour modes, resolution options, file types and Using tools with real time example layers, blending, filters and designing of website, Designing banners for web site, web advertisements. Introduction of HTML 5.0, Working on basic structure of markup language and Hands on experience on markup language, Hands on experience on semantic markup language. Working on Head section, structural tags and attributes for construction of web site, content/ media tags for construction of web site. Construction of web site: Working on forms, Home page and Other page, Adding navigational elements and links, Adding asides and side bars and applying styles, Creating popup windows, Hands on experience with cascading style sheets: Border images, shadows, gradients, Text-shadow and stroke etc., Adobe Dream weaver: Basics, Meta tags, Script tags, Links, Inserting tables, images, videos, Template design and Importing etc., Live website design project: Designing template, Adding menu system to project Insertion of web banners and advertisements and Final project evaluation.

Designing for Social media- Blog, Twitter, Face book. Familiarization and working on SEO, web analytics and Making use of web analytics Configuration of Web Analytics with domain name. Introduction of User Interface design and hands on experience - User Interface elements and principles, creating mockups, buttons, menus and forms, Designing of icons and vector objects, Creating pages in HTML by using user interface design. Applying style sheets and navigational elements and link, Designing of mobile application screen mockups/ screen in HTML, Presentation of developed websites, Final Practical examination.

Suggested Readings

1. Abdullah (2011). Web technology. Himalaya publishing house.
2. Chisholm and May (2008). Universal Design for Web Applications: Web Applications That Reach Everyone, O'Reilly Media.
3. Gray Shelly, Denise Woods, William Dorin (2008). HTML: Comprehensive Concepts and Techniques. Published by Cengage Learning, 2008.
4. Thakur Mukesh (2010). Multimedia and Applications. First edition.
5. https://www.udemy.com/course/web-design-secrets/
6. https://kinsta.com/blog/web-design-courses/
7. https://www.sanjaywebdesigner.com/articles/web-design-course-learn-from-best-website-designing-tips/

Semester VIII

S. No.	Course Title	Credit Hours
1.	Student READY Program (RAWE/ In plant /Industrial Attachment/ Internship / Experiential learning /Hands on Training/ Project Work)	20
	TOTAL	**20**

* Student will undertake Project Work based on the field work/ Community Problems and Needs identified in any one area (like Community Malnutrition/ Health Foods for Non-Communicable Diseases (NCD)/ Community Health and Hygiene/ Developmental Challenges of Children/ Processing of local foods/ Nutri Garden/ Immunity boosting indigenous plants/ natural dyeing/ Environmental Issues, Value addition of Agriculturebased byproducts, etc.)

SKILL ENHANCEMENT COURSES

Indicative options for SEC-I module*****(any one module to be selected)***

Module	Course	Credit Hours
Bakery and Confectionary Management- I	Breads and Buns	2 (0+2)
	Biscuits and Cookies	2 (0+2)
Textile Design and Embellishment- I	Textile Dyeing and Printing	2 (0+2)
	Fabric Embellishment	2 (0+2)
Event Management and Housekeeping- I	Housekeeping and Service Management-I	2 (0+2)
	Floral Art and Design-I	2 (0+2)
Childhood Development and Assessment- I	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)
	Developmental Assessment II (Childhood)	2 (0+2)
Extension Education for Community Development- I	Audio Visual Aids for Communication	2 (0+2)
	Extension Teaching Methods	2 (0+2)

Indicative options for SEC-II module*****(any one module to be selected)***

Module	Course	Credit Hours
Bakery and Confectionary Management- II	Cakes and Pastries	2 (0+2)
	Chocolate Making	2 (0+2)
Textile Design and Embellishment- II	Indian Embroideries	2 (0+2)
	Quilting and Patchwork	2 (0+2)
Event Management and Housekeeping- II	Housekeeping and Service Management II	2 (0+2)
	Event Planning and Management	2 (0+2)
Childhood Development and Assessment- II	Infant Stimulation Practices	2 (0+2)
	Health Practices in Early Childhood	2 (0+2)
Extension Education for Community Development- II	Computerized Instructional Aids Production	2 (0+2)
	ICT and New Media	2 (0+2)

Indicative options for SEC-III modules*****(any one module to be selected)***

Module	Course	Credit Hours
Food Service Management – I	Quantity Cookery	1 (0+1)
	Traditional Indian Foods	1 (0+1)
Fashion Designing – I	Garment Designing	1 (0+1)
	Accessory Designing	1 (0+1)
Interior Design and Decoration – I	Interior Designing and Decoration I	1 (0+1)
	Floral Art and Design II	1 (0+1)
Early Childhood Care and Education – I	Establishment of ECCE centers	1 (0+1)
	Program Planning and Execution in ECCE centers	1 (0+1)
Communication Technology and Journalism – I	Print Journalism	1 (0+1)
	Electronic Journalism	1 (0+1)

Indicative options for SEC- IV modules*****(any one module to be selected)***

Module	Course	Credit Hours
Food Service Management – II	Food Preservation and Storage-I	1 (0+1)
	Food Preservation and Storage-II	1 (0+1)
Fashion Designing- II	Fashion Illustration	1 (0+1)
	Portfolio Development	1 (0+1)
Interior Design and Decoration – II	Interior Accessories and Furnishings	1 (0+1)
	Interior designing and decoration II	1 (0+1)
Early Childhood Care and Education – II	Management of ECCE centre	1 (0+1)
	Monitoring and evaluation of ECCE centre	1 (0+1)
Communication Technology and Journalism – II	Audio and Video Recording	1 (0+1)
	Instructional Video Production	1 (0+1)

**The universities/ institutes are free to include other options for SEC as per the local needs and facilities available, also to interchange the modules in between semesters. The modules can be taken in campus or off-campus.

ONLINE COURSES
10 credit hours (Non-gradial)

The students will have to take 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons) Community Science program.

The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal. The courses will be non-gradial as separate certificates would be issued by institutes offering the courses.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the satisfactorily completed courses in final transcript issued to the student.

Suggestive list of online courses from SWAYAM/ MOOC

- Digital Media
- Basics of Photography
- Ergonomics Workplace Analysis
- Design, Technology and Innovation
- Visual Communication Design for Digital Media
- Certificate course in Environmental Sustainability
- Consumer Protection Legislation
- Communication and Extension for Sustainable Development
- Intellectual Property
- NGO'S and Sustainable Development
- Counseling Psychology
- Gender Sensitization: Society Culture and Change
- Basics of Health Promotion and Education Intervention

- Psychology of Stress, Health and Well-being
- Diet Management in Health and Disease
- CAD/CAM Computer Aided Design / manufacturing
- Dairy and Food process and products technology
- Digital Image Processing
- Thermal Processing of Foods
- Nanotechnology, Science and Applications
- Testing of Functional and Technical Textiles
- Smart Materials and Intelligent System Design
- Advanced Textile Printing Technology
- Textile Product Design and Development
- Applied Ergonomics
- Evaluation of Textiles Materials
- Silkworm rearing and reeling technology
- Textiles and Quality Analysis
- Refresher Course in Advances in Textile Engineering
- Food Science and Processing
- Diet Management in Health and Disease
- Maternal Infant Young Child Nutrition
- Human Nutrition and Biochemistry
- Personality Development and Communication Skills
- Public Speaking
- Personality Development
- Emotional Intelligence
- Yoga Practices 1
- Yoga Practices 2
- Ethics: Theories and Applications
- Information Sources and Library Services
- Qualitative Research Methods and Research Writing
- Home Science – Extension and Communication Management
- Food Science and Processing
- Food Safety and Quality Control
- Interior Materials and Finishes
- Interior Furniture and Furnishings
- Communication Skills and Computer Operations
- Human Resource Management
- Business Plan and Finance Management

HORTICULTURE

Course Curricula for Undergraduate program in Horticulture UG-Certificate (Horticulture) UG-Diploma (Horticulture) B.Sc. (Hons) Horticulture

INTRODUCTION

Horticulture, viewed as one of the best options for crop diversification in agriculture, has a great significance especially as the fruits and vegetables are important components of diet required to meet the nutritional needs of the masses. Equally important is the commercial cultivation of flowers and landscape gardening/ architecture. In the current scenario of need for diversified agriculture, the sustainable horticulture is only possible if the trained workforce, especially graduates/ postgraduates in horticulture are readily available. The need based up gradation of course curriculum, especially with a focus on skill enhancement of graduates is required. The skill empowerment along with the sound theoretical knowledge of the subject is the basic requirement of a trained graduate. That is the essence of NEP-2020 and has been embedded in all the Undergraduate degree programs through formation of 6th Deans' Committee and its subsequent discussions on developing need/ skill-based course curriculum in different subjects including Horticulture. Apart from skill enhancement, the other provisions of NEP especially multiple entry and exit options have been taken into consideration in restructured course curriculum of B. Sc. Horticulture degree program. There is provision of exit after 1st year and 2nd year and the students thus will be entitled for UG Certificate in Horticulture and UG Diploma in Horticulture, respectively. Likewise, entry options have been provided for the degree. The value-added courses (VAC) and ability enhancement courses (AEC) along with choice-based skill enhancement courses (SEC) have also been added in the proposed course curriculum.

The course curriculum in horticulture has been restructured based on the elaborate discussion among the members of 6th Deans' Committee as well as the subject experts from different Universities/ Institutes imparting horticulture degrees, representing different regions of the country. The discussion to improve course curriculum

has been made among the faculty of all the three disciplines of horticulture namely fruits, vegetables and flowers.

The sketch of semester wise courses I to VIII, along with detailed course contents are presented in the following text.

HIGHLIGHTS

- The whole course program of B.Sc. (Hons) Horticulture will be of 167+10*(*NC-MOOC) =177 credit hours.
- More weightage has been given to skill development courses in first two years. Students have been given flexibility and choice in selection of skill development courses from a bouquet of multiple skill development modules offered in all the four semesters of first two years.
- Students will be given 12 (4+4+2+2) credits of skill-based courses distributed in first, second, third and fourth semester, respectively, so that they acquire enough knowledge and skill through hands-on training in related domain to get certificate by the end of first year and Diploma at the end of second year if they opt to exit.
- In first year, after completing the course requirement, there is provision of extra 10-credit Internship of two months' period for Industry placement/Industry exposure/ Hands on training in related domain of skill acquired to get first-hand experience to become eligible for the award of Certificate on exit. Similarly, internship is necessary for those exiting after diploma course. Students will complete requirement of given course credits plus 10 weeks Internship each in first and second year.
- These students are expected to acquire competency and confidence to start their own enterprise and have adequate competency for getting jobs.
- More emphasis has been given in proper amalgamation of theory and practical to provide them hard core knowledge of Horticulture discipline.
- 10 credits of non-credit courses are at the discretion of students. Students have the choice of MOOC to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also have flexibility to complete these non credit elective courses of 10 credits throughout the span of the degree program.
- On successfully completing the four years' degree requirement, the student will be given undergraduate degree of B.Sc. (Hons) Horticulture.
- During the 5th semester, the students will have to undertake study tour of 10-12 days' duration, which will be counted as 2 credits (Non-gradial).
- The elective courses will be offered in 7th semester. The students can choose any one of the electives and pursue in total of 20 credits in the semester.
- The Universities will have flexibility to include more courses as electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.
- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.

Entry and Exit Options

The entry and exit options for the UG programs in Horticulture are shown in the Figure.1

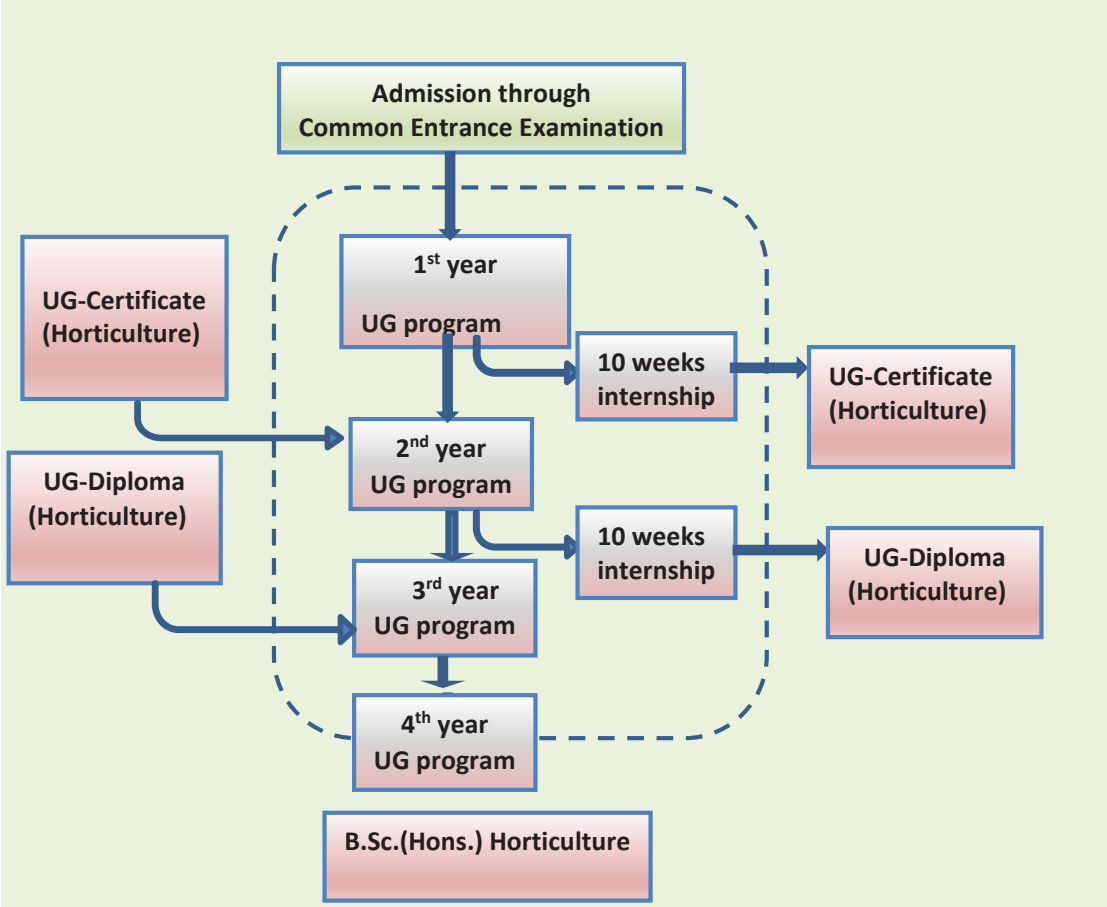

Fig. 1 Entry and Exit options for the UG program in Horticulture

Eligibility for Entry into 1st year UG program: 10+2 Science with PCM/PCB/Agriculture/ Horticulture

Exit options

1. UG Certificate in Horticulture- (exit after first year and completion of 10 weeks internship)
2. UG Diploma in Horticulture- (exit after second year and completion of 10 weeks internship)
3. B. Sc. (Hons) Horticulture- (on successful completion of four-year degree requirements) ACADEMIC program

Semester wise course distribution

Semester	Course Title	Credit Hours	Total Credits
First Year			
I semester			
1	Deeksharambh (Induction cum Foundation Course)	2 (0+2) NG Non-gradial	**21 (8+13) + 2 (Non-gradial)**
2.	Fundamentals of Horticulture	3 (2+1)	
3.	Plant Propagation and Nursery Management of Fruit and Plantation crops	3 (1+2)	
4.	Commercial production of Flower crops	3 (1+2)	
5.	Farming Based Livelihood Systems	3 (2+1)	
6.	Sprinkler and Micro irrigation systems	2 (1+1)	
7.	Communication Skills	2 (1+1)	
8.	Skill Enhancement Courses (SEC-I)*	4 (0+4)	
9.	NCC-I/NSS-I	1 (0+1)	
II Semester			
1.	Introduction to Major Field crops	3 (2+1)	**22 (10+12)**
2.	Commercial Production of Spices and Plantation crops	3 (2+1)	
3.	Plant Propagation and Nursery Management in Vegetables, Flowers and Medicinal crops	3 (1+2)	
4.	Personality Development	2 (1+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Skill Enhancement Courses (SEC-II)*	4 (0+4)	
8.	NCC-II/NSS-II	1 (0+1)	
Post-II Semester			
1.	Internship (for 10 weeks-only for exit option for award of UG-Certificate)	10 (0+10)	
Second Year			
III Semester			
1.	Fundamentals of Soil Science	3 (2+1)	**20 (11+9)**
2.	Commercial Fruit Production	4 (3+1)	
3.	Precision Farming and Protected Cultivation	3 (2+1)	
4.	Seed Production of Vegetable, Tuber and Spice crops	3 (2+1)	
5.	Disease Management of Horticulture crops	3 (2+1)	
6.	Physical Education, First Aid,Yoga Practices and Meditation	2 (0+2)	
7.	Skill Enhancement Courses (SEC-III)*	2 (0+2)	

Semester	Course Title	Credit Hours	Total Credits
	IV Semester		
1.	Commercial Vegetable Production	4 (3+1)	**22 (13+9)**
2.	Farm Power and Machinery for Horticulture	3 (2+1)	
3.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
4.	Urban and Peri Urban Horticulture	2 (1+1)	
5.	Agriculture Marketing and Trade	3 (2+1)	
6.	Pest Management of Horticulture crops	3 (2+1)	
7.	Introductory Agrometeorology and Climate Change	2 (1+1)	
8.	Skill Enhancement Courses (SEC-IV)*	2 (0+2)	
	Post-IV semester		
1.	Internship (for 10 weeks-only for exit option for award of UG-Diploma)	10 (0+10)	
	Third Year		
	V Semester		
1.	Fundamentals of Plant Breeding	3 (2+1)	**20 (12+8) + 2 (Non gradial)**
2.	Growth and Development of Horticultural crops	3 (2+1)	
3.	Soil Fertility and Nutrient Management	3 (2+1)	
4.	General Microbiology	3 (2+1)	
5.	Information and Communication Technology in Horticulture	3 (1+2)	
6.	Introductory Crop Physiology	2 (1+1)	
7.	Basic Statistics and Experimental Designs	3 (2+1)	
8.	Education Tour	2 (0+2) Non-gradial	
	VI Semester		
1.	Introductory Agroforestry	3 (2+1)	**22 (13+9)**
2.	Laboratory Techniques for Horticultural crops	2 (0+2)	
3.	Principles of Biochemistry	3 (2+1)	
4.	Dryland Horticulture	3 (2+1)	
5.	Economics and Marketing	3 (2+1)	
6.	Principles and Practices of Natural Farming	2 (1+1)	
7.	Horticulture Based Integrated Farming System	3 (2+1)	
8.	Processing and Value Addition of Horticulture crops	3 (2+1)	
	Fourth Year		
	VII Semester		
1.	**Elective Courses**- Students will opt one of the elective discipline and accordingly the courses offered by University may be taken		**20**
	Fruit Science	20	
	Vegetable Science	20	
	Floriculture and Landscaping	20	

Semester	Course Title	Credit Hours	Total Credits
	VIII Semester		
1.	Student Ready (RAWE/ Industrial Attachment/ Project work/ Internship)	20 (0+20)	**20**
		TOTAL	**80 + 87 +4 #**
		Grand total	**167 +4 #**

* From the basket of Skill Enhancement Course (SEC) modules

Non gradial courses- *Deeksharambh* (0+2); Edu Tour (0+2)

Department/ section wise course breakup

Foundation course		
	Course Title	**Credits**
1.	*Deeksharambh* (2 weeks)	2 (0+2)

Skill Enhancement Courses (SEC)		**Credits**
1.	Mushroom Cultivation	2 (0+2)
2.	Apiculture	2 (0+2)
3.	Orchard Floor Management	2 (0+2)
4.	Landscape Gardening	2 (0+2)
5.	Packing and Packaging of Horticultural Crops	2 (0+2)
6.	Farm Machinery	2 (0+2)
7.	Introduction to Forestry	2 (0+2)
8.	Installation, Operation and Maintenance of Micro-irrigation System	2 (0+2)
9.	Computer Programming and Data Structures	2 (0+2)
10.	Turf and Turf Management	2 (0+2)
11.	Post-Harvest Management of Horticultural Produce	2 (0+2)
12.	Nursery Production in Horticulture crops	2 (0+2)
13.	Seed Production techniques in Vegetable crops	2 (0+2)
14.	Sericulture	2 (0+2)

Note: The University/ Institute may offer more Skill Enhancement courses relevant to the region and the subject.

Core (Major/ Minor Course)

Fundamentals of Horticulture	3 (2+1)
Plant Propagation and Nursery Management of Fruit and Plantation crops	3 (1+2)
Plant Propagation and Nursery Management in Flowers and Medicinal and crops	3 (1+2)
Growth and Development of Horticulture crops	3 (2+1)
Commercial Fruit Production	4 (3+1)

Commercial Vegetable Production	4 (3+1)
Commercial Production of Flower crops	3 (1+2)
Dry land Horticulture	3 (2+1)
Urban and Peri Urban Horticulture	2(1+1)
Sprinkler and Micro Irrigation systems	2 (1+1)
Laboratory Techniques for Horticulture crops	2 (0+2)
Processing and Value Addition of Horticulture crops	3 (2+1)
Farm Power and Machinery for Horticulture	3 (2+1)
Pest management of Horticulture crops	3 (2+1)
Disease Management of Horticulture crops	3 (2+1)
Information and Communication Technology in Horticulture	3 (1+2)
Commercial production of spices and plantation crops	3 (2+1)
Precision farming and protected cultivation	3 (2+1)
Horticulture based integrated farming system	3 (2+1)
Seed production of vegetables, tuber and spice crops	3 (1+2)
Soil Fertility and Nutrient Management	3 (2+1)
Fundamentals of Soil Science	3 (2+1)
Introduction to Major Field crops	3 (2+1)
Fundamentals of Plant Breeding	3 (2+1)
Introductory Agroforestry	3 (2+1)
Introductory Agrometeorology and Climate Change	2 (1+1)
Economics and Marketing	3 (2+1)
Introductory Crop Physiology	2 (1+1)
Principles of Biochemistry	3 (2+1)
General Microbiology	3 (2+1)
Basic Statistics and Experimental Designs	3 (2+1)
Principles and Practices of Natural Farming	2 (1+1)

Elective courses

Fruit Science	
Production Technology of Tropical Fruit crops	3 (2+1)
Production Technology of Sub tropical and temperate Fruit crops	3 (2+1)
Breeding of Fruit crops	3 (2+1)
Canopy Management in Fruit crops	3 (2+1)
Biotechnological Approaches and Micropropagation in Fruit crops	3 (2+1)
Production Technology of Arid Fruit crops	3 (2+1)
Postharvest Management for Fruit crops	2 (1+1)

Vegetable Science	3 (2+1)
Production Technology of Warm Season Vegetable crops	3 (2+1)
Production Technology of Cool Season Vegetable crops	3 (2+1)
Production Technology of Tuber crops	3 (2+1)
Breeding of Vegetable crops	3 (2+1)
Biotechnological approaches and Micropropagation in Vegetable crops	3 (2+1)
Postharvest Management of Vegetable crops	3 (2+1)
Protected cultivation of Vegetable crops	2 (1+1)
Floriculture and Landscaping	
Turf Management	2 (1+1)
Protected Cultivation of Flower crops	3 (2+1)
Value Addition in Floriculture	3 (2+1)
Breeding of Ornamental crops	3 (2+1)
Principles of Landscape Architecture	3 (2+1)
Commercial Floriculture and Landscaping	3 (2+1)
Postharvest handling of Floriculture crops	3 (2+1)

Note: The University/ Institute may offer more electives/courses relevant to the subject.

Multidisciplinary Courses (MDC)

Farming Based Livelihood Systems	3 (2+1)
Entrepreneurship Development and Business Management	3 (2+1)
Agriculture Marketing and Trade	3 (2+1)

Value Added Courses (VAC)

Environmental Studies and Disaster Management	3 (2+1)
Agriculture Informatics	3 (2+1)

Ability Enhancement Courses (AEC)

Communication Skills	2 (1+1)
Personality Development	2 (1+1)
Physical Education, First Aid and Yoga	2 (0+2)
NCC/NSS	2 (0+2)

SUMMARY OF CREDIT DISTRIBUTION

Type of courses	Credits
Core courses (major and minor/s)	112
Common courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Internship / Student READY	20
Non-Gradial Courses [*Deeksharambh* and Educational Tour]	4*
Online Courses / MOOCs	10**
Total	167 + 10**

*Non-Gradial ** Online courses

Table 1. Credits Allocation Scheme of UG Horticulture program (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	11	3[2]		1[3] + 2[4]	1	-	21	2[1]		
II	9	3[5]	3[6]	1[3] + 2[4]	4	-	22	-	10[12]	
III	16	--		2[8]	2	-	20	-		
IV	14	3[9]	3[10]	----	2	-	22	-	10[13]	**10**
V	20	-	-	-	-	-	20	2[11]		
VI	22	-	-	-	-	-	22	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2weeks duration)
[2] Farming based Livelihood systems
[3] NCC/NSS
[4] Communication Skills
[5] Entrepreneurship Development and Business Management
[6] Environmental Studies and Disaster Management
[7] Personality Development
[8] Physical Education, First Aid and Yoga Practices
[9] Agriculture Marketing and Trade
[10] Agriculture Informatics
[11] Study tour (10-14 days)
[12] Only for those opting for an exit with UG-Certificate
[13] Only for those opting for an exit with UG-Diploma

Detailed Syllabi

Semester I

Deekshaarambh (Induction cum Foundation program) 2 (0+2) NG

The activities to be taken under *Deeksharambh*, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform for

- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in University
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
- Creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Fundamentals of Horticulture 3 (2+1)

Objectives

1. To provide knowledge of horticulture in a brief and prescribed manner
2. To familiarize students with principles and practices of management for Horticultural crops

Theory

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic and Natural farming, market chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable/ flower seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits and vegetable crops, maturity standards, harvesting, grading, packaging and storage.

Suggested readings

1. Chattopadhyay T K 2013. A Textbook on Pomology Vol I-IV. Kalyani Publications. New Delhi.
2. Kumar Prasad 2014. Principles of Horticulture 2nd edn. Agrobios India.

3. Misra Kausal Kumar and Kumar Rajesh 2014. Fundamentals of Horticulture. Biotech Books.
4. Peter K V 2009. Basics Horticulture. New India Publishing Agency.
5. Salunkhe D K and Kadam S S 2013. A handbook of Fruit Science and Technology. CRC Press.
6. Singh Jitendra 2011. Basic Horticulture. Kalyani Publications. New Delhi.
7. Singh Neeraj Pratap 2005. Basic concepts of Fruit Science 1st edn. IBDC Publishers.

Plant Propagation and Nursery Management of Fruit and Plantation crops 3 (1+2)

Objectives

1. To know different methods of propagation techniques
2. Horticultural significance of specialized vegetative structures
3. To study the different types of plant propagation methods and structures

Theory

Status and importance of plant propagation and nursery production in fruits and plantation crops. Sexual and asexual methods of propagation, their advantages and disadvantages. Apomixes, seed dormancy, types of dormancy and methods to overcome seed dormancy. Use of vegetative propagation methods viz. division, cutting, layering, budding and grafting. Propagation structures in nursery production: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds and poly-houses. Use of growth regulators in nursery production. Components of a nursery, maintenance of mother trees and seed gardens, collection of scion-wood, and bud wood certification. Growing medium and containers used for nursery production. Role of tissue culture techniques viz. micropropagation, micrografting and meristem culture. Nursery registration act. Management of insect-pests and diseases in nursery. Cost of establishment of a modern nursery.

Practical

Selection of site, soil sterilization and preparation of beds for nursery raising. Preparation of growing media and use of different nursery containers for containerized nursery production in fruits and plantation crops. Seed treatments for breaking dormancy and prevention of nursery diseases. Sowing of seed, raising and maintenance of rootstock/ seedlings. Practicing different vegetative propagation methods, viz. cutting, layering, grafting and budding. Preparation of plant growth regulators for seed germination and vegetative propagation. Digging, labelling and packing of field grown nursery plants. Familiarisation with propagation structures mist chamber, greenhouse, glasshouse, polyhouse and net house; and their maintenance. Micropropagation and hardening of plants. Tissue culture media preparation, explant preparation, *in vitro* culturing and shoot tip culture, primary and secondary hardening of tissue culture plants. Maintenance of nursery records. Identification and management of insect-pests and diseases in nursery. Project formulation for small and high-tech nurseries. Nursery Accreditation.

Suggested readings

1. Davies F T Geneve R L and Wilson S B 2018. Hartmann and Kester's Plant Propagation Principles and Practices 9th edn. Pearson. USA.
2. ICAR 2019. Handbook of Horticulture 2nd edition ICAR Vol 1 and 2. New Delhi.

3. Peter K V 2002. Plantation crops. National Book Trust India, New Delhi.
4. Sharma R R and Krishna Hare 2017. Textbook of Plant Propagation and Nursery Management. C B S Publishers. New Delhi.
5. Sharma R R and Srivastava Manish 2004. Plant Propagation and Nursery Management. IBDC Publishers. New Delhi

Commercial Production of Flower crops 3 (1+2)

Objectives

- Imparting knowledge about climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, nutritional and irrigation requirements, intercultural operations, weed management, physiological disorders, postharvest management, plant protection measures of major flower crops.

Theory

Scope and importance of flower cultivation. Soil, climate, varieties, propagation, special intercultural operations, fertilizers requirement, irrigation, use of growth regulators, weed management, plant protection measures, harvesting, grading, packaging, and storage of rose, jasmine, carnation, chrysanthemum, gladiolus, marigold, tuberose and cut foliage crops under open/partial shade. Seed production of flowering annuals.

Practical

Introduction of flower crops. Identification of commercial varieties, propagation techniques, bed preparation, soil decontamination, planting and layout, training, pruning, staking, growing media, potting and repotting. Containers for growing flowers for exhibition. Fertilizer calculations and application, growth regulator application. Weed management and plant protection measures. Special horticultural practices in cut flower and cut foliage crops. Determination of harvest indices, harvesting methods and postharvest handling. Commercial Standards, Packing methods. Project preparation. Visit to commercial flower market and progressive growers having high-tech farms.

Suggested readings

1. Arora JS. Introductory Ornamental Horticulture.
2. Aswath C, Bose TK, Dutta K, Reeta Bhatia and Saha T N Commercial Flowers Vol. 2.
3. Bose TK, Maiti RG, Dhua RS, Das P. Floriculture and Landscaping (Vol.1).
4. Purohit S S and Bhardwaj Prasad R L A 2016. Textbook of Production Technology of Vegetable and Flower Crops Agrobios (India); 400 p.
5. Randhawa, G. S. and Mukhopadhyay Amitabha 1986. Floriculture in India, Allied Publishers, - 660 p.
6. Singh A K 2006 Flower Crops: Cultivation and Management, New India Publishing,Gardening - 480 p.
7. Vishnu Swarup 1967 Garden Flowers: Buy Garden Flowers, National Book Trust, India, 261 p.

Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming- based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming- based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7. [Google Scholar]
3. Carloni, A. 2001 Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.

4. Dixon, J., Gulliver, A. and Gibbon, D. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries. In FAO, The State of Food and Agriculture, FAO, Rome, Italy.
6. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
7. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Sprinkler and Micro irrigation systems **2 (1+1)**

Objectives

To acquaint the students with the basic knowledge of modern irrigation systems

Theory

Sprinkler irrigation: adaptability, types, problems and prospects. Sprinkler/micro sprinkler irrigation system design: steps, layout, selection, design of lateral, sub-main and main pipeline, selection of pump and power unit. Performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency. Micro irrigation system: types, merits and demerits, components. Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics and design steps. Steps for proper operation of a drip irrigation system. Maintenance of micro irrigation system: clogging, filter cleaning, flushing and chemical treatment. Fertigation: advantages, limitations, methods, fertilizers solubility and their compatibility, precautions, frequency, duration and injection rate. Economics: Cost estimation of sprinkler and micro irrigation system.

Practical

Study of different components, design and installation of sprinkler irrigation system. Determination of precipitation pattern, discharge and uniformity coefficient. Study of different components, design and installation of drip irrigation system. Determination of pressure discharge relationship and emission uniformity for emitter. Study of different types of filters and determination of filtration efficiency. Determination of rate of injection and calibration for chemigation / fertigation. Design of irrigation and fertigation schedule for crops. Field visit to micro irrigation system and evaluation of drip system. Cost economics of sprinkler and drip irrigation system.

Suggested readings

1. Biswas, R.K. 2015. Drip and Sprinkler Irrigation. New India Publishing Agency.
2. Goyal, M.R. 2016. Micro Irrigation Management Technological Advances and Their Applications - Innovations and Challenges in Micro Irrigation. CRC Press.
3. James, L.G. 1993. Principles of Farm Irrigation System Design. Krieger publishing Company, Malabar, Florida.
4. Mane, M.S. and Ayare, B. L. 2019. Principles of Sprinkler Irrigation. Jain Brothers, N. Delhi, 4th edn.
5. Mane M.S and Ayare, B. L. 2019. Principles of Drip Irrigation. Jain Brothers, New Delhi.

Communication Skills 2 (1+1)

Objectives

1. To acquire competence in oral, written and non-verbal communication
2. To develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
2. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
3. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
4. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
5. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
6. Pease Allan, 1998, Body Language. Sudha Publications, Delhi.
7. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
8. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
9. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

National Cadet Corps (NCC) **1 (0+1)**

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS) **1 (0+1)**

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load. The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme,

youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.

- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Introduction to Major Field Crops 3 (2+1)

Objectives

1. To provide in-depth understanding about crop response to variable agronomic factors
2. To inculcate the skill of raising field crops with appropriate agronomic practices for higher productivity

Theory

Classification and distribution of field crops, definition, concept and principles of multiple cropping, mixed cropping, intercropping, relay and alley cropping, crop rotation. Economic importance, soil and climatic requirement, varieties, cultural practices for raising major cereals (rice, wheat, maize), pulses (gram, soybean, arhar moong), oilseeds (rapeseed and mustard, sunflower, groundnut), cash crops (cotton, sugarcane) and fodder crops (sorghum, *bajra*, berseem, oats). Principles and practices of green manuring.

Practical

Identification of crop plants, seeds, weeds. Preparation of cropping scheme. Method of sowing, fertilizer and herbicide application in field crops. Calculation of fertilizer and herbicide dose.

Suggested readings

1. Anonymous, 2023, Package of practices for *kharif* crops.
2. Anonymous, 2023, Package of practices for *rabi* crops.
3. Reddy T Y and Reddy G H S, 2020, Principles of Agronomy, Kalyani Publishers, Ludhiana.
4. Singh Chidda, 2020, Modern techniques of raising field crops. Oxford and IBH Publication.

Commercial Production of Spices and Plantation crops 3 (2+1)

Objectives

- To inculcate the skill of raising spices and plantation crops with appropriate agronomic practices for higher productivity

Theory

Present status and importance of spice crops, soil and climate requirements, commercial varieties, site selection, layout, sowing time and methods, nutritional and irrigation requirements, intercropping, weed control, physiological disorders, harvesting, post-harvest management and plant protection measures of the following crops: Black pepper, turmeric, ginger, garlic, clove, cinnamon, fenugreek, cumin, ajowain, coriander, fennel, cardamom, Vanilla, betelvine and celery.

Area, production and export potential of plantation crops, varietal wealth, cultivation systems, multitier cropping, high density planting, nutritional and irrigation requirements, weed management, training and pruning, physiological disorders, maturity indices, harvesting, postharvest management and plant protection measures of the following crops: Coffee, tea, cashew, rubber, coconut, arecanut, cocoa and oil palm.

Practical

Identification of seeds and plants, propagation, nursery raising, field layout, planting methods, cultural practices, harvesting and handling, visit to fields and marketing centres.

Suggested readings

1. Kumar N 2018. Introduction to spices plantation crops medicinal and aromatic plants. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
2. Peter K V 2002. Plantation crops. National Book Trust India, New Delhi.
3. Pruthi J S 1998. Major Spices of India Crop Management and Post Harvest Technology ICAR. Krishi Anusandhan Bhavan, Pusa, New Delhi.

Plant Propagation and Nursery Management in Vegetables, Flowers and Medicinal crops 3 (1+2)

Objectives

1. Study of biology and types of propagation, tissue culture and physiology of seed, seed storage and dormancy
2. Knowledge of nursery management, nursery establishment and nursery techniques for plant propagation
3. Propagation from specialized structures in major vegetable, flower crops, medicinal and aromatic plants

Theory

Nursery management practices for vegetables, flowers and medicinal crops, Biology of plant propagation, Sexual and Asexual plant propagation, physiology of seed, seed storage and dormancy, physiology of cutting, layering, grafting, budding. Tissue culture, Maintenance of elite germplasm and mother stock. Propagation from specialized modified plant parts, crop specific plant propagation

practices in commercial vegetables and flowers. Nursery techniques and crop specific propagation methods of medicinal crops.

Practical

Identification of planting material, commercial varieties of vegetable, flowers and medicinal crops. Propagation and multiplication, seed production. Potting, repotting and maintenance of houseplants. Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking. Harvesting techniques. Crop-specific plant propagation practices. Visit to local nurseries and florist centers. Marketing requirements and strategies for sale of important crops.

Suggested readings

1. Plant Propagation: Principles and Practices by Hartmann and Kester
2. Plant Propagation and Nursery Management by Tarai Ranjan Kumar

Personality Development 2 (1+1)

Objectives

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.

3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
6. Mile, D.J., 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
7. Smith, B., 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R., 2009, Social and Personality Development (6th edn). Belmont, CA: Wadswor.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Desai Vasant, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House
4. Gupta CB. 2001, Management Theory and Practice. Sultan Chand and Sons.
5. Indu Grover. 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
6. Khanka SS. 1999, Entrepreneurial Development. S. Chand and Co.
7. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
8. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D, 1995, Effective Managerial Leadership. Deep and Deep Publ.
10. Singhal R.K., 2013, Entrepreneurship Development and Management, Katson Books.
11. Tripathi PC and Reddy PN., 1991, Principles of Management. Tata McGraw Hill.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

1. To expose and acquire knowledge on the environment
2. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (g) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T., Vennila, S., Prasanthrajan, M. and Umesh Kanna, S. 2023 Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science.1st edn. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002.
6. Prasanthrajan, M. 2018. Objective Environmental Studies and Disaster Management, ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India.
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

National Cadet Corps (NCC) 1 (0+1)

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.

- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS) 1 (0+1)

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

S. No.	Course Title	Credit Hours
INT	Internship (10 weeks)	**10 (0+10)** *

*Mandatory Internship to get certificate after 1 Year exit.

SEMESTER III

Fundamentals of Soil Science 3 (2+1)

Objectives

- To make the students aware about the importance of soil in relation to soil formation, texture, structure, water, temperature, aeration, nutrient availability, and soil microbiology, soil survey

Theory

Composition of earth's crust, soil as a natural body – major components. Eluviation, Illuviation formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/ particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsell colour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus–Neutronprobe–soilwatermovement–classification–aerialphotography– satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock and Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS and LUP, ISSS, LTFE and NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Quantification of minerals and their abundance. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of field capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by fieldmeth Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.

Suggested readings

1. Das D K. 2011. Introductory Soil Science Third Revised Edition Kalyani Publishers. Ludhiana.
2. Fundamentals of Soil Science by Indian Society of Soil Science Second Revised Edition 2009. Indian Society of Soil Science. New Delhi.
3. Nyle C Brady and Weil Ray R. 2016. The Nature and Properties of Soils 15th Edition. Prentice Hall of India Pvt Ltd. New Delhi.
4. Sharma Pradeep K. 2017. Introduction to Soil Physics First Edition Westville Publishing House. New Delhi.

5. Saha A K. 2008. Text Book of Soil Physics Reprinted. Kalyani Publishers. Ludhiana.
6. Sehgal J A. 2005. Textbook of Paedology Concepts and Applications Kalyani Publishers. Ludhiana.

Commercial Fruit Production 4 (3+1)

Objectives

- To acquaint the students with the cultivation techniques for commercially important tropical, sub-tropical and temperate fruit crops

Theory

Area, production and export potential, varieties, soil and climate requirements, propagation techniques, planting density and systems, training and pruning, high density planting, ultra-high density planting, mechanization, management of water, nutrient and weeds, Physiological disorders, Special production problems, insect-pests, diseases and their control measures. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops: mango, banana, citrus, guava, litchi, grapes, papaya, pineapple, ber, aonla, pomegranate, sapota, jamun, date palm, apple, pear, peach, plum, cherry, almond, apricot, walnut, kiwifruit, hazelnut, chestnut, pecan nut, plantation crops (coconut, cashew nut, tea, coffee, cocoa, arecanut, palmyrah palm and strawberry.

Practical

Description and identification of varieties. Training and pruning, application of manure, fertilizer and irrigation, weed control, maturity standards, harvesting, handling, grading and packaging of fruits. Visit to commercial orchards.

Suggested readings

1. Bal J S. Fruit Growing.
2. Chattopadhyay T K. A Textbook on Pomology Vol I-IV.
3. George Acquaah. Horticulture Principles and Practices.
4. ICAR. Handbook of Horticulture Vol I-II.
5. Singh Ranjit. Fruits. New Book Trust, New Delhi, 303 p.

Precision Farming and Protected Cultivation 3 (2+1)

Objectives

- The students will learn about the basics of cultivation of plants under protected conditions

Theory

Precision farming – laser levelling, mechanized direct seed sowing; seedling and sapling transplanting, site specific input application. Protected cultivation technology: Introduction, techniques of protected cultivation, types of Green Houses, Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and

heating purposes. Green house equipment, materials of construction for traditional and low-cost green houses. Irrigation systems used in protected cultivation, Typical applications, passive solar green house, hot air greenhouse heating systems, greenhouse drying. Cost estimation and economic analysis. Choice of crops for cultivation under protected structures, problems/constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT)/ hydroponics.

Practical

Laser levelling procedure and field visit. Study and field visit for mechanized direct seed sowing and transplanting. Study of different types of greenhouses based on shape, construction and cladding materials. Studies on different environment control parameters in greenhouses. Estimation of drying rate of agricultural products inside greenhouse. Testing of soil and water to study its suitability for growing crops in protected structures. The study of fertigation requirements for greenhouse crops and estimation of E.C and pH in the fertigation solution. The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization/sterilization. Visit to commercial protected cultivation structures. Economics of protected cultivation.

Suggested readings

1. Brahma S 2019. Precision Farming and Protected Cultivation. NIPA, New Delhi.
2. Michael A M 2008. Irrigation Theory and Practices. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Kumar S 2002. Precision Farming and Protected Cultivation: Concepts and Applications. Narendra Publishing House, New Delhi.

Seed Production of Vegetable, Tuber and Spice Crops 3 (2+1)

Objectives

1. Students will acquire skill for certification and storage of seed production of vegetable, tuber and spice crops
2. Students will be trained for on-farm operations of different seed multiplication activities of vegetable, tuber and spice crops.

Theory

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage, packaging and labelling of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, tuber crops like potato, spice crops like coriander, fenugreek, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. seed priming and pelleting, Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units

Suggested readings

1. Arya Singh P. 2003. Vegetable seed Production Principles. Kalyani Publishers. Ludhiana.
2. Hazra P and Som M G. 2009. Vegetable seed production and Hybrid Technology. Kalyani Publishers, Ludhiana.
3. Kulkarni G N. 2002. Principles of Seed Technology. Kalyani Publishers, Ludhiana.
4. Ram HH, Upadhyay R, Dubey R K and Mandal B C. 2017. Vegetable seed production-Principles and practices. Kalyani Publishers, Ludhiana.
5. Singh, S P. 2001. Seed production of commercial vegetables. Agrotech Publishing, Udaipur

Disease Management of Horticulture crops 3 (2+1)

Objectives

1. To identify various pathogen structures and diagnose the diseases of horticultural crops in field
2. To understand the disease cycle and epidemiology of various diseases of horticultural crops
3. To give an overview of various disease management methods (cultural, physical biological, chemical)

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases under protected conditions and of fruits, plantation, medicinal, aromatic, vegetables, ornamental, and spice crops *viz* mango, litchi, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine, senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum*, Tephrosia, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossed, tuberose, gerbera, anthurium, geranium, marigold, gladiolus. Important post-harvest diseases of fruit, plantation, medicinal, aromatic, vegetables, ornamental and spice crops and their management. Etiology, symptoms and integrated management of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases of fruits, plantation, medicinal, aromatic, vegetables, ornamental and spice crops. Collection and preservation of diseased plant specimen.

Suggested readings

1. Gupta S K and Thind T S 2018. Disease problems in Vegetable Production. Scientific Publishers India, P.586.
2. Gupta S K Sharma R C and Sharma M 2017. Diseases of Vegetable. Ornamental and Spice crops. Scientific Publishers India.
3. Mehrotra R S and Aggarwal A 2003. Plant Pathology. 2nd edn. Tata Mc Graw Hill Publication Com Ltd, P.846.
4. Pathak V N 1989. Diseases of fruit crops. Oxford and IBH Publication Comp. New Delhi, P.309.
5. Rangaswami G and Mahadevan A 2002. Diseases of crop plants in India 4th Edition. Prentice Hall of India Pvt Ltd. New Delhi, P.536.
6. Singh R S 1987. Diseases of vegetable crops 2nd Edition. Oxford and IBH Publication. Comp New Delhi, P. 362.
7. Singh R S 2018. Plant Diseases 10th edn. Oxford and IBH Publication. New Delhi, P.821.
8. Singh R S 2018. Diseases of fruit crops 2nd edn. Med Tech. New Delhi, P.281

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra,

Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra

- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Commercial Vegetable Production 4 (3+1)

Objectives

- Student shall gain expertise on commercial cultivation of vegetable crops

Theory

Importance of Olericulture. Vegetable gardens. Vegetable classification, area, production and varieties. Package of practices of tomato, brinjal, chillies, capsicum, moringa and okra. Cucurbitaceous vegetables- cucumber, ridge gourd, ash gourd, snake gourd, bottle gourd, bitter gourd, pumpkin and melons. Cole crops - cabbage, cauliflower and knol-khol. Bulb crops - onion and garlic. Beans and peas - French beans, cluster beans, dolichos beans, peas and cowpea. Tuber crops - potato, sweet potato, tapioca, colocasia, yams. Root crops - carrot, radish, turnip and beet root. Leafy vegetables – broccoli, lettuce, spinach, chinese cabbage and asparagus.

Practical

Identification of vegetable crops and seeds; Planning, layout and maintenance of kitchen garden; Direct sowing of vegetables, Bed preparation and method of nursery sowing; Transplanting of vegetable seedlings; Method of fertilizer application and calculation of different fertilizer doses; Intercultural operations in vegetable crops, Harvesting, grading and packaging of vegetable crops, Economics of vegetable crops, Visit to commercial vegetable farms.

Suggested readings

1. Bose and Som 2003. Vegetable Crops. Vol I II and III. Naya Prokash.
2. Dhaliwal M S 2014. Handbook of Vegetable Crops. Kalyani Publishers.
3. Fageria M S, Choudhary B R and Dhaka Vegetable Crop Production Technology Vol II. Kalyani Publishers.
4. Hazara and Som 2015. Technology for Vegetable Production and Improvements. Naya Prokash.
5. ICAR 2019. Handbook of Horticulture Vol 1 and Vol 2, ICAR.

Farm Power and Machinery for Horticulture 3 (2+1)

Objectives:

- To acquaint students of the tools available at his disposal for doing the work in horticulture (mechanical power source: engines/ tractors; machines and tools for harvesting the horticultural produce: tillage equipment, planting equipment, plant care equipment)

Theory

Basic concepts of various forms of energy; Tractors, power tillers and their types and uses Introduction about IC Engines: Basic principles of operation of compression, ignition and spark ignition engines; two stroke and four stroke engines; Crank system, valve system, fuel supply system, cooling and lubrication systems; power transmission systems; broad understanding of performance and efficiency. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of improved indigenous ploughs, mould board ploughs, disc and rotary ploughs, offset rotavators. Secondary tillage implements construction and function of cultivators, harrows, levellers, ridgers and bund formers. Adjustments affecting performance in tillage equipment. Calculation of bite length of rotavator. Post-hole digger. Introduction about planting and transplanting equipment: potato planters, small seed planter, nursery sowing machinery, vegetable transplanters, plastic mulch and drip laying machinery. Introduction about intercultural machinery. Sprayers: Types, working principle, manual and tractor operated, gun-type and boom type. Special purpose sprayers: aero-blast sprayers, electrostatic sprayers, sprayer calibration and nozzle spacing. Safety features and safe use, shrub cutters, pick positioner; grafting, pruning and training tools and equipment; sweep, rotary weeders, tractor operated pruners. Crop harvesting equipment: potato diggers, fruit-pluckers, seed extraction machine.

Practical

Calculation on force, power and energy. IC engines – showing the components of dismantled engines. Familiarization with engine systems Primary and secondary tillage implements: hitching, adjustments and operations. Operation of post hole digger. Operation of planting and transplanting machinery. Operation of vegetable transplanter, plastic mulch and drip laying machinery. Operation of Inter-culture equipment including offset rotavator in orchard; calibration of plant protection equipment, calculation of dilution ratio and operation; operation of power weeder, shrub cutter. Operation of crop harvesting equipment and seed extraction machine. Operation of shrub cutters, fruit-pluckers, pick positioner.

Suggested readings

1. Sahay Jagdishwar. Elements of Agricultural Engineering.
2. Kepner R A, Bainer R and Barger E L. Principles of Farm Machinery.
3. MichaelA M and OjhaT P. Principles of Agricultural Engineering.
4. Culpin C. Farm Machinery.
5. Rodichev V and Rodicheva G. Tractors and Automobiles.

Agriculture Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with agricultural-informatics, its components and applications in agriculture.

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-Word and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/ Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

Urban and Peri urban Horticulture 2 (1+1)

Objectives

1. To acquaint the students about the unban and peri-urban horticulture and its types.
2. To impart the knowledge about the cultivation practices of horticultural crops in urban and peri-urban areas.

Theory

Introduction to urban and peri-urban horticulture: Definition, importance, characteristics and scope. Types of urban and peri-urban gardens and their characteristics: Terrace gardening, vegetable gardening, container gardening, rooftop gardens, community gardens, vertical gardens, hydroponics and aeroponics. Selection of site, planting material, media (soil and soilless) preparation and nutrient management for cultivation of vegetables, herbs, fruits, flowers and ornamental plants. Protected cultivation in urban and peri-urban areas. Making and maintenance of lawns. Interior and exterior landscaping in urban and peri-urban households. Water and waste management, waste water recycling and its use in landscaping. Insect-pest and disease management in urban horticulture.

Practical

Site selection and layout of various urban and peri-urban gardens. Preparation of growing media and potting mixtures. Types of containers, nursery raising and planting for rooftop gardens. Irrigation and nutritional management in urban and peri-urban horticulture. Visit to fruit nutrition garden, vegetable kitchen garden and public gardens.

Suggested readings

1. Alka Singh, Patel NL and Ahlawat TR 2016. Handbook of Urban and Periurban Horticulture; Publisher: ‍Ambica; 1st edn.
2. Sumangla HP, Malhotra S K and Chowdappa P 2013. Urban and peri-urban horticulture- A perspective.

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture

4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy.

Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested readings:

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory

4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Pest management of Horticulture crops 3 (2+1)

Theory

Classification of insect-pests. Dynamics of EIL and ETL. Methods of pest control - host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Recent technologies for insect-pest management. Insecticides, classification, formulations, first aid and antidotes. IPM – importance and principles. Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests of various fruit (tropical, sub-tropical and temperate), vegetable, ornamental, plantation, spice, medicinal, aromatic crops and under protected conditions. Pest surveillance. Storage insects – Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests attacking stored fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops' produce and their processed products. Insecticides residue problems in fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops and their maximum residue limits (MRLs). Waiting periods for insecticides on various crops.

Practical

Identification of insect-pests of various fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops in field and their produce during storage, and their symptoms of damage. Identification of biocontrol agents and natural enemies. Insecticide formulations. Pesticide application appliances. Calculation of insecticide quantity for preparing spray material.

Suggested readings

1. Integrated Pest management concepts and approaches by G S Dhaliwal and Ramesh Arora
2. Agricultural Pests of South Asia and their Management by A S Atwal and G S Dhaliwal
3. Essentials of Agricultural entomology by G S Dhaliwal, Ram Singh and B S Chillar
4. Applied Animal Ecology by A S Atwal and S S Bains

Introductory Agrometeorology and Climate Change 2 (1+1)

Objectives

Training graduate students with respect to management the climate aberration for sustainable crop production

Theory

Agrometeorology – definition, scope. Earth atmosphere - its composition, extent and structure. Atmospheric weather variables. Elements and factors of weather and climate. Atmospheric pressure. Wind, types, daily and seasonal variation. Cyclone, anticyclone. Land and sea breeze. Solar radiation - solar constant, depletion, short and long wave, thermal radiation, net radiation, albedo. Atmospheric temperature, inversion, lapse rate, daily and seasonal variations, vertical profile. Energy balance of earth. Atmospheric humidity, saturation, vapor pressure, condensation. Dew, fog, mist, frost. Precipitation, process, types. Cloud formation and classification. Artificial rainmaking. Monsoon - mechanism and importance in Indian agriculture. Weather hazards. Agriculture and weather relations. Modifications of microclimate. Climatic normal for crop and livestock production. Weather forecasting – types and applications. Climate change and impacts on agriculture.

Practical

Visit to agrometeorological observatory. Site selection of observatory and exposure of instruments and weather data recording. Measurement of total, short and long wave radiations and their estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of radiation intensity using BSS. Measurement of maximum and minimum air temperatures, tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and critical analysis of rainfall. Computation of drought indices. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

Suggested readings

1. Avi H S 1985. Introduction to Agrometeorology. Oxford and IBH Publishing Co., New Delhi.
2. Lenka D 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.
3. Mavi H S and Tupper G J 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
4. Mavi H S 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Nanjappa H V and Ramachandrappa B K 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
6. Pattersen S 1958. Introduction to Meteorology. Mc. Graw Hill Book Co. Inc., New York
7. Prasad Rao G S L H V 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Srivastava A K and Tyagi P K 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
9. Yellamanda Reddy T and Sankara Reddi G H 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.

S. No.	Course Title	Credit load
INT	Internship (10 weeks)	**10 (0+10) ***

*Mandatory Internship to get Diploma after 2 Year exit.

Semester V

Fundamentals of Plant Breeding 3 (2+1)

Theory

Historical development, concept, nature and role of plant breeding. Major achievements and future prospects. Genetics in relation to plant breeding. Modes of reproduction. Male sterility - genetic consequences and cultivar options. Domestication, acclimatization and introduction. Centres of origin/diversity. Components of genetic variation, heritability and genetic advance. Genetic basis and breeding methods in self-pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population. Multiline concept. Concepts of population genetics and Hardy-Weinberg Law. Genetic basis and methods of breeding cross - pollinated crops. Modes of selection. Population improvement schemes - ear to row method, modified ear to row, recurrent selection schemes. Heterosis and inbreeding depression. Development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops - clonal selection. Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding. Mutation breeding - methods and uses. Breeding for important biotic and abiotic stresses. Introduction to biotechnological tools - DNA markers and marker assisted selection. Participatory plant breeding. Plant Breeders' and Farmers' Rights.

Practical

Plant breeder's kit. Study of germplasm of various crops. Study of floral structure of self-pollinated and cross pollinated crops. Emasculation and hybridization techniques in self and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Maintenance of breeding records and data collection. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. Working out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Suggested Readings

1. Chahal GS and SS. Gosal 2001. Principles and Procedures of Plant Breeding.
2. Fehr WR. 1987 Principles of Cultivar Development –Theory and Practice.
3. Poehlman JM and Sleper DA.1995. Breeding Field Crops.
4. Singh BD 2011. A text book in Plant Breeding, Kalyani Publishers, Ludhiana.
5. Singh BD. 2008 Plant Breeding – Principles and Methods.

Growth and Development of Horticulture crops 3 (2+1)

Objectives

- To understand the physiology of canopy management, flowering, fruit setting and seed development in horticultural crops
- To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments

- To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments
- To understand the usage of synthetic growth regulators and their applications for overall manipulation of growth and development in horticultural crops

Theory

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalization and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested readings

1. Jain V K 2006. Fundamentals of plant physiology (Ninth edition). S, Chand and Co., New Delhi, India.
2. Mohr H and Schopfer P 1995. Plant Physiology. Springer-Verlag, Berlin, Germany.
3. Richard P Marini: Physiology of Pruning Fruit Trees. http://pubs.ext.vt.edu/422/422-025/422-025.htmlTOC.
4. Salisbury F B and C W Ross 1992. Plant physiology (Fourth edition). Wadworth publishing Co., California, USA.
5. Taiz L and Zeiger E 2003. Plant physiology (Third edition). Sinaure Associates, Inc., Publishers, Massachusetts, USA.

Soil Fertility and Nutrient Management 3 (2+1)

Objectives

- To acquaint students with the basic knowledge of soil fertility and nutrient management, as to understand the key factors affecting plant growth and development.

Theory

Plant nutrients - classification and sources; Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting availability of major, secondary and micro-nutrients to plants. Measures to overcome deficiency and toxicities. Soil fertility- different approaches for soil fertility evaluation; Soil testing for available nutrients; Critical levels of different nutrients in soil. Plant analysis- total and rapid tissue tests-critical levels of nutrients in plants; DRIS method; Deficiency symptoms-indicator plants. Biological method of soil fertility evaluation. Soil test-based fertilizer recommendations to crops. Site-specific and plant need-based nutrient management. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions. Integrated plant nutrient supply system and its management. Soil quality in relation to sustainable agriculture-acid, salt affected and calcareous soils, characteristics, nutrient availabilities, Reclamation- mechanical, chemical and biological methods.

Practical

Analytical Instruments- principles, calibration and applications; Estimation of available nitrogen, available phosphorus, available potassium and available sulphur in soil; Estimation of exchangeable calcium and magnesium in soil, Estimation of available micronutrients in soils; Preparation of plant samples for analysis; Estimation of nitrogen, phosphorus and potassium in plants.

Suggested readings

1. Aggarwal JP Yawalkar KS and Bokde S 2011. Manures and Fertilizers 11th edn. Agri Horticultural Publishing House. Nagpur.
2. Basak Ranjan Kumar 2016. Fertilizers A Text Book, Fourth edition. Kalyani Publishers. Ludhiana.
3. Brady NC 1999. Nature and Properties of Soils 10th Edition.
4. Das PC 2015. Manures and Fertilizers Third edition Kalyani Publishers. Ludhiana.
5. Goswami NN. 2009. Fundamentals of Soil Science 2nd Edition. ISSS New Delhi.
6. Kanwar JS. Soil Fertility Theory and Practice ICAR. New Delhi.
7. Soil Science an Introduction 2015. Indian Society of Soil Science. New Delhi.
8. Tisdale SL Nelson WL and Beaton JD 1985. Soil Fertility and Fertilizers 4th Edition. Mac Millan Publishing Company. New York.

General Microbiology 3 (2+1)

Objective

To provide knowledge about general concepts of microbiology.

Theory

Evolution and scope of microbiology. History of microbiology. Microbial classification, nomenclature and identification. Taxonomic groups. General methods of classifying bacteria.

Microscopy and microscopes: Smears and staining. Morphology and fine structure of bacteria. Cultivation of bacteria, nutritional requirements. Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus, Microbiology of water and food Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Metabolism in bacteria –ATP generation Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, Gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Suggested Readings

1. Dubey RC and Maheshwari DK. 2013. A Textbook of Microbiology S Chand Publishing, New Delhi.
2. Gerard JT, Berdell RF and Christine LC. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
3. Johanne MW, Linda MS and Woolverton CJ. 2013. Prescott's Microbiology. 9th edn. McGraw-Hill Higher Education, NY, USA.
4. Pelczar MJ, Chan ECS and Noel RK. 1998. Microbiology. 5th edn. Tata McGraw-Hill Education, New Delhi.
5. Purohit SS. 2001. Microbiology-Fundamentals and Applications. Agrobios, New Delhi.
6. Sharma PD. 1999. Microbiology. Rastogi Publications, Meerut, India.
7. Tauro P, Kapoor KK and Yadav KS. 2002. Introduction to Microbiology. New Age International (P) Limited Publications, New Delhi, India.

Information and Communication Technology in Horticulture 3 (1+2)

Objectives

- To learn basics of computing and its practical use in communication

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; Introduction to Computers, hardware and software; input and output devices; word and character representation;

features of machine language, assembly language, high-level language and their advantages and disadvantages; Operating Systems, definition and types, Applications of Word Processing / Spreadsheet /Presentation /Databases for document creation and Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database concepts and types, uses of DBMS in Horticulture; Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTML and IP and Video conferencing, Introduction to e- Horticulture, concepts and applications, Use of ICT in Horticulture.

Practical

Practice with latest operating system for creating Files, Folders, File Management. Use of Word Processing/ Spreadsheet/ Presentation/ Databases with latest software packages; Creating a spreadsheet, Use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creating Database, preparing queries and reports, creation and operation of E mail account; Demonstration of Agri-information system using Mobile Apps. Internet applications: Web browsing, handling of audio-visual equipment. Planning, preparation, presentation of posters, charts. Introduction of Geospatial Technology of generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

Suggested readings

1. Comer Douglas E. 2018. The Internet book: everything you need to know about computer networking and how the Internet works. Chapman and Hall/CRC.
2. Crowther R, Joe L, Ash Blue, and Wanish G. 2014. HTML5 in Action. Manning.

I Introductory Crop Physiology 2 (1+1)

Objectives

1. To study different physiological plant aspects such as water uptake and movement in plants, nutrient absorption, assimilation
2. To study factors affecting photosynthesis and its importance in plants

Theory

Water Relations in Plants: Role of water in plant metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation. Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and on-cyclic electron transfer, CO_2 fixation – C3, C4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpiration

pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Readings

1. Bendre AM and Pande PC, 2009, Introductory Botany. Rastogi publication, Meerut.
2. Bhatia KN, 2015, Plant Physiology. Trueman Book Company, Jalandhar.
3. Dutta AC, 2013, A Textbook of Botany. Oxford University Press, Oxford Lecture Schedule.
4. Gardner FP, Pearce R Band Mitchell RL, 2003, Physiology of Crop Plants. Scientific Publishers, Jodhpur.
5. Jain V K, 2019, Fundamentals of Plant Physiology. S Chand Publishers, New Delhi.

Basic Statistics and Experimental Designs 3 (2+1)

Objectives

1. To understand the analytical techniques for data analysis and interpretation
2. To help students to compete for various competitive examinations

Theory

Definition of statistics, its use and limitations. Variable statistics, types and sources of data, classification and tabulation of data. Construction of frequency distribution tables – graphic presentation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve, cumulative frequency curve. Measures of central tendency: mean, median, mode, geometric mean, harmonic mean, percentiles and quartiles for raw and grouped data, Measures of dispersion: range, quartile deviation, mean deviation, standard deviation for raw and grouped data, coefficient of variation. Skewness and kurtosis. Probability-definition, additive and multiplicative law for two events, Normal distribution and its properties. Introduction of sampling. basic concepts, sampling vs. Complete enumeration parameter and statistic. Sampling techniques (simple random sampling: lottery method and random number table method). Tests of significance, Null hypothesis, Alternate hypothesis, Type I and II Error, one and two tail tests, level of significance and confidence interval. Large sample tests for mean (Single sample and two samples), Student's t-test for single sample, two samples and paired t-test, F-test, Chi-square test for application of attributes (contingency table) and test for goodness to fit of Mendalian ratios, Yates' correction for continuity. Correlation-scatter diagram and Karl Pearson coefficient of correlation for ungrouped data and its testing. Linear regression and its properties. Inter-relation between 'r' and the regression coefficient, Introduction to design of experiment- Basic principles of experimental design-replication, randomization and local control, Analysis of variance (ANOVA) and its assumptions, analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Comparisons based on means-critical difference.

Practical

Construction of frequency distribution tables and frequency curves, Measures of central tendency: mean, median, mode, geometric mean, harmonic mean, percentiles and quartiles. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation for raw and grouped data, coefficient of variation. Skewness and kurtosis. Probability. Large sample tests for

mean, Student's t-test, F-test and Chi-square test, Correlation coefficient 'r' and its testing, Fitting of regression equations, Analysis of CRD, RBD and LSD.

Suggested Readings

1. Bansal M L, Singh Sukhminder, Singh Tejinderpal and Jindal Rakesh Kumar. 2014. Statistical Methods for Research Workers. Kalyani Publishers 4th edn.
2. Chandal S R S.2014. A Handbook of Agricultural Statistics. Achal Prakashan Mandir.
3. Gupta S P. 2021. Statistical Methods. Sultan Chand and Sons.
4. William G Cochran and George W Snedecor. 2014. Statistical Methods. Wiley India Pvt Ltd. 8th edn.

Semester VI

Introductory Agroforestry 3 (2+1)

Objective

- To develop skill and expertise on forestry, agroforestry models, wood-based industries, and nursery raising practices of important tree species

Theory

Forestry – Introduction, related definitions. Objective of silviculture. Forest classification. Indian Forest Policies. Artificial and natural regeneration – objectives, choice between natural and artificial regeneration. Coppicing, pollarding, root suckers. Forest mensuration – objectives, instruments for diameter, height and age measurement. Tree stem form, form factor, form quotient. Measurement of volume of felled and standing trees.

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Choice of species with respect to site/economic uses and constraints on tree growing. Agroforestry systems, sub-systems and practices, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree - crop species for agroforestry. Agroforestry projects – national and overseas. National Agroforestry Policy 2014. MPTs (*Azadirachta indica, Acacia* species, Bamboos, *Dalbergia sissoo*, *Eucalyptus* species, *Grewia optiva*, *Gmelina arborea*, *Leucaena leucocephala, Melia* species, *Populus deltoides*, *Tectona grandis*, etc.) – nursery and planting management practices.

Major wood-based industries in India – Timber, panel, plywood, paper and pulp, match, etc. – Raw material requirements and their procurement. Economics and marketing of products raised in agroforestry systems.

Practical

Identification of seeds and seedlings of tree species. Diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery practices for *Azadirachta indica, Acacia* species, Bamboos, *Dalbergia sissoo*, *Eucalyptus* species, *Grewia optiva*, *Gmelina arborea*, *Leucaena leucocephala, Melia* species, *Populus deltoides*, *Tectona*

grandis, etc. Layout of agroforestry plantation and study the compatibility of MPTs with agricultural crops. Visit to social forestry/agroforestry plantations and nearby forest-based industries.

Suggested readings:

1. Chundawat DS and SK Gautham. 2017. Textbook of Agroforestry. Oxford and IBH Publishing, (ISBN: 9788120408326).
2. Nair PKR, Kumar BM and VD Nair. 2021 An introduction to agroforestry – four decades of scientific developments. DOI: https://doi.org/10.1007/978-3-030-75358-0. Springer Cham
3. Parthiban KT, Umarani R, Kanna SU, Sekar I, Rajendran P and Durairasu P. 2014. Industrial agroforestry - Perspectives and Prospective. Scientific Publishers, Jodhpur.
4. Tejwani KG. 2001. Agroforestry in India. Concept Publishing Company.

Laboratory Techniques for Horticulture crops 2 (0+2)

Objectives

1. To impart practical training for the analysis of physio-chemical attributes of fruit.
2. To acquaint students with operating of various labware and equipment's

Practical

Safety measures and maintenance of laboratory. Acquaintance with the laboratory equipment's used for quality analysis of fruits and vegetables. Preparation of different standard solutions. Sampling procedures for quantitative analysis. Determination of physiological loss in weight, specific gravity, fruit size, shape, juice content, firmness and fruit colour. Assessment of textural properties of harvested produce. Determination of biochemical components in horticultural produce viz. TSS, pH, acidity, sugars, carbohydrates, total antioxidants, starch index (SI), ascorbic acid, chlorophyll, anthocyanin, and carotenoids, phenols. Leaf nutrient analysis using Kjeldahl apparatus, spectrophotometer, flame photometer and atomic absorption spectrophotometer. Compilation and analysis of data and interpretation of results.

Suggested readings

1. AOAC International 2003. Official Methods of Analysis of AOAC International. 17th edn. Gaithersburg MD USA Association of Analytical Communities USA.
2. Rangana S 2001. Handbook of Analysis and Quality control for fruits and vegetable products.2nd edn. Tata McGraw Hill. New Delhi.
3. Linskens H F and Jackson J F 1995. Fruit Analysis Springer.
4. Leo M L 2004. Handbook of Food Analysis 2nd edn. Vols I-III USA.
5. Sarkar A K and Mahapatra 2015. Plant nutrient disorders diagnosis and management. New India Publishing Agency. New Delhi, India.

Principles of Biochemistry 3 (2+1)

Objective

- To learn about the basic concepts of biochemistry

Theory

Recapitulation of basic chemistry and biology. Water, pH and buffers. Acid-base balance. Cellular constituents and their structure and function, amino acid and proteins, carbohydrates, lipids and bio-membranes, nucleic acids. Dissolved molecules– vitamins and minerals. Enzymes-function, properties and mechanism. Metabolism of cellular constituents, basic concepts of bioenergetics. Carbohydrate metabolism-glycolysis and glycogenolysis, HMP pathway, TCA cycle and gluconeogenesis. Electron transport chain. Photosynthesis. Lipid metabolism-β-oxidation, ketone bodies, fatty acid synthesis. Amino acid metabolism - general reactions of nitrogen assimilation and excretion. Biosynthesis of DNA, RNA and protein- replication, transcription, translation and genetic code. Regulation of gene expression.

Practical

Preparation of buffers and pH determination. Preparation of colloids. Qualitative and quantitative tests of carbohydrates, lipids and proteins. Tests of enzyme action- potato oxidase, urease, salivary amylase. Paper chromatography of amino acids or carbohydrates ascending and descending. Determination of starch and sugar. Analysis of proximate constituents in food.

Suggested readings

1. Eric E. Conn, Paul K. Stumpf, George Brueninh and Roy H. Doi. Outlines of Biochemistry- 5th Edition.
2. Satyanarayana U and Chakrapani U. Biochemistry by Dr.
3. Lehninger. Principles of Biochemistry. David L. Nelson and Michael M. Cox.

Dryland Horticulture 3 (2+1)

(This course will be taught in collaboration with Department of Soil Science.)

Objectives

1. To acquaint the students with the soil and climatic features of the dry land areas

2. To impart the knowledge about the soil and water conservation technologies for dry land areas

3. To impart the knowledge about the production technologies for fruit crops of dry land areas

Theory

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rainfed areas, scarce water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. Watershed development, soil and water conservation methods-terraces, contour bunds etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits etc. In-situ water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti-transpirants, growth regulators, organic amendments etc. water use efficiency-need based, economic and conjunctive use of water, micro irrigation systems and fertigation etc. Water quality: characterization and use in horticultural crops. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, in-situ grafting, deep pitting/planting, canopy

management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

Rainfall patterns. Contour bunding/trenching, micro catchments; rainfall erosivity and soil erodibility indices, measurement of runoff, soil loss and their control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Morphological and anatomical features of drought tolerant fruit crops.

Suggested readings

1. Chundawat B S 1990 Arid Fruit Culture. Oxford and IBH, New Delhi.
2. Jatav M K, Saroj P L and Sharma B D 2019. Dryland Horticulture. New India Publishing Agency. https://www.perlego.com/book/1975613/dryland-horticulture-pdf ISBN 10.1201/9781003245902.
3. Rathore R S, Singh R P, Singh P K and Singh P S 2020 Dryland Horticulture Cultivation and Management. Publisher AGROBIOS (INDIA) ISBNs: 978-81-943776-5-8 pp: 1-340
4. Singh Jitendra 2022 Drylands Horticulture, ISBN : 9789355400048

Economics and Marketing 3 (2+1)

Objectives

1. To introduce the student about the concepts, subject matter and importance of study of economics.
2. To make the student understand about the terms - goods, service, value, price, wealth, welfare.
3. To impart knowledge to the student about the concept of wants, utility and consumer surplus.
4. To expose the students to the laws of marginal utility and their importance.
5. To provide an overview to the students about the concept of demand, kinds of demand and law of demand.
6. To aware the student about the concept of supply, law of supply and price determination of commodity under equilibrium condition.
7. To aware the student about factors of production and their characteristics
8. To provide an overview to the student about the Gross Value Added.
9. To expose the students to the concept of marketing, market, price spread, marketing efficiency, integration, marketing functions, classification of markets and marketing channels.
10. To aware the students about the market intelligence, constraints in marketing of agricultural produce.
11. To impart knowledge to the student about Basic guidelines for preparation of project reports, Bank norms, Insurance, SWOT analysis, crisis management.

Theory

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Value Added. Role of Biotechnology/Agriculture Sector in National GVA.

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence. Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value-added products; Identification of marketing channel; Calculation of price spread; Identification of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Suggested Readings

1. Acharaya S S and Aggarwal N L, Agricultural Marketing in India.
2. Gupta R D, Elementary Economic Theory.
3. Dewett K K, Modern Economic Theory.
4. Dewett K K and Verma J D Elementary Economic Theory.
5. Reddy Subba S, Raghu Ram P, Neelkanta T V and Bhawani Sastry Devi, Agricultural Economics.

Principles and Practices of Natural Farming 2 (1+1)

Objectives

1. To teach students the concept, need and principles of native ecology-based production under natural farming

2. To impart practical knowledge of natural farming and related agricultural practices in Indian and

3. global environmental and economic perspectives.

Theory

Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming; Definition; Objective of natural farming, Essential characteristics and Principles of natural farming; Scope and importance of natural farming. Main Pillars of natural farming; Methods/ types/ schools of natural farming. Introduction to concept of ecological, water, carbon and nitrogen foot prints, Concept and evaluation of ecosystem services, Rearing practices for animals under natural farming, Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Mechanization in natural farming, Processing, labelling, economic considerations and viability, certification and standards in natural farming, marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of natural farming and chemical free agriculture, Case studies and success stories in natural farming and chemical free traditional farming, Entrepreneurship opportunities in natural farming.

Practical

Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming principles at the farm; Indigenous technical knowledge (ITK) for seed,

tillage, water, nutrient, insect-pest, disease and weed management; On-farm inputs preparation methods and protocols, Studies in green manuring *in-situ* and green leaf manuring, Studies on different types of botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient, insect and pest and disease management; Weed management practices in natural farming; Techniques of indigenous seed production, storage and marketing, Partial and complete nutrient and financial budgeting in natural farming; Evaluation of ecosystem services in natural farming (Crop, Field and System).

Suggested Readings

1. Ayachit SM. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation 4: 205.
2. Boeringa R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
3. Dabholkar Shripad A. 2021. Plenty For All: Natural Farming A To Z Prayog Pariwar Methodology and Prayog Pariwar Prayog Pariwar.
4. Das P, Das S K, Arya H P S, Reddy G Subba, Mishra A and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
5. Ecological Farming -The seven principles of a food system that has people at its heart. May 2015, Greenpeace.
6. Faires Nicole. 2016. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides).
7. FAO. 2018. The 10 elements of agro-ecology: guiding the transition to sustainable food and agricultural system. https://www.fao.org/3/i9037en/i9037en.pdf Agro ecosystem Analysis for Research and Development Gordon R. Conway.1985
8. Fukuoka M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
9. Fukuoka M. 1985. The Natural Way of Farming: The Theory and Practice of Green Philosophy. Japan Publications, Tokyo, 280 pp.
10. Hill S B and Ott P (Eds.). 1982 Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
11. HLPE. 2019. Agroeeological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and nutrition of the Committee on World Food Security, Rome. https://fao.org/3/ea5602en/ea5602en.pdf.
12. INFRC. 1988. Guidelines for Nature Farming Techniques. Atami, Japan. 38 pp.
13. Khurana A and Kumar V. 2020. State of Organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
14. Lindenmayer David B, Macbeth Suzannah M et al. 2022. Natural Asset Farming: Creating

Productive and Biodiverse Farms.

15. Malhotra R and Babaji S D. 2020. Sanskrit Non Translatable- The importance of Sanskritizing English. Amaryllis, New Delhi India.

16. Nalini S. 1996. *Vrikshayurveda* (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telengana), India. 94pp.

17. Nalini S. 1999. *Krishi-Parashara* (Agriculture by Parashara) by Parashara. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.

18. Nalini S. 2011. *Upavana Vinoda* (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 64p

19. Prathapan Paramu. 2021. Natural Farming Techniques: Farming without tilling.

20. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, Ottho Heldringstraat.

21. Shamasastry R. 1915. Kautilya's Arthashastra.

22. UK Behera. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.

23. कम लागत प्राकृततककृतिः आचार्य देव व्रत, pp 1-166.

Horticulture Based Integrated Farming System **3 (2+1)**

Objective

To familiarize the students for farm management to deliver more sustainable agriculture

Theory

Farming System-scope, importance, concept and factors affecting types of farming system. Farming system components and their maintenance. Evolution and diversity of farming systems; Stone age survival to swidden farming, Nomadic pastoralism and agro-pastoralism in warm and cold deserts of India. Horticulture crop based livestock farming, subsistent livelihoods in rain-fed areas of India. Industrial and semi-industrial agriculture- agro-enterprises, agribusiness systems, their produce for marketing grains, vegetables, fruits, flowers, fibre crops, medicinal and aromatic plants. Value addition for income enhancement. Integrated farming system- objectives, characteristics and its advantages and disadvantages. Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques in relation to horticulture crops. Resource cycling and flow of energy in different horticulture- based farming system and environment. Sustainable livelihood agriculture- problems and its impact on horticulture. Indicators of soil health and environment for horticulture- based IFS. Vertical farming definition, their scope and objectives; multilayer farming, hydroponics, aeroponics-their definition, requirements, advantages, disadvantages and opportunities; Site specific horticulture- based IFS models; horticulture and vegetable intercropping systems; high density plantation; bankable IFS models; rooftop farming; Farm typology. Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers' field.

Practical

Preparation of horticulture based cropping scheme and integrated farming system models for irrigated, rainfed and dryland situations. Preparation of enriched farmyard manure and vermicompost. Visit to urban waste recycling unit and model farmers' field. Preparation of farm lay out plans. Estimating horticulture crop yields. Energy budgeting in different horticulture crops. EC/pH/TDS of water; Hydroponics nutrient management, Designing of polyhouse, Net house and tunnel house; Mushroom farming and its various types; Seeding with soilless media. C-sequestration, budgeting, footprints. Organic fertigation in orchards; use of biorationales. Working out ecological optimum zones. Project making exercises for establishment of horticulture-based production models under different situation.

Processing and Value Addition of Horticulture crops 3 (2+1)

Objectives

1. To make the students familiarize with the principles of food preservation and processing
2. To develop the skill set in students for value addition of horticultural produce by application of suitable food processing methods

Theory

Importance and scope of fruit and vegetable processing industry in India. Food pipeline-losses in postharvest, processing and distribution systems. Losses in post-harvest operations. Unit operations in food processing-pasteurization, sterilization, blanching, canning, and bottling. Principles and guidelines for selecting the location and establishment of processing units. Principles and methods of preservation by heat, low temperature, sugar and salt, chemicals. Methods of fruit juice extraction, preparation of RTS, cordials, nectars, squashes, syrups, candies, crystallized fruits, preserves, jam, jelly, marmalade, fermented beverages, vinegar, pickles, chutneys and sauces. Tomato and mushroom products, freezing of fruits and vegetables. Drying of fruits and vegetables. Processing of plantation crops, their products, spoilage in processed foods, quality control of processed products, Government policy on import and export of processed fruits. Food laws.

Practical

Equipment used in food processing units. Canning of fruits and vegetables. Preparation and quality evaluation of squash, RTS, syrup, jam, jelly, marmalade, candies, preserves, chutneys. Dehydration of fruits and vegetables, tomato products, refrigeration and freezing, cut out analysis of processed foods. Visit to food processing units.

Suggested readings

1. Fellows P J. 2005. Food Processing Technology: Principles and Practice. CRC Press, Woodhead Publishing Ltd.
2. Girdhari Lal, Siddappa G S and Tandon G L. 1967. Preservation of Fruits and Vegetables. Indian Council of Agricultural Research, New Delhi.
3. Kureel M K. 2020. Postharvest Management and Value Addition of Fruits and Vegetables. Bio-Green Books.
4. Potter Norman N. 2013. Food Science. Springer Science and Business Media.

5. Srivastava R P and Kumar Sanjeev. 2019. Fruit and Vegetable Preservation – Principles and Practices. CBS Publishers and Distributors Pvt Ltd.

ELECTIVE COURSES

Fruit Science

1.	Production Technology of Tropical Fruit crops	3 (2+1)
2.	Production Technology of Sub tropical and Temperate Fruit crops	3 (2+1)
3.	Breeding of Fruit Crops	3 (2+1)
4.	Canopy Management in Fruit Crops	3 (2+1)
5.	Biotechnological Approaches and Micro-propagation in Fruit Crops	3 (2+1)
6.	Production Technology of Arid Fruit Crops	3 (2+1)
7.	Postharvest Management of Fruit Crops	2 (1+1)

Vegetable Science

8.	Production Technology of Warm Season Vegetable Crops	3 (2+1)
9.	Production Technology of Cool Season Vegetable Crops	3 (2+1)
10.	Production Technology of Tuber Crops	3 (2+1)
11.	Breeding of Vegetable Crops	3 (2+1)
12.	Biotechnological approaches and Micropropagation in Vegetable Crops	3 (2+1)
13.	Postharvest Management of Vegetable Crops	3 (2+1)
14.	Protected cultivation of Vegetable Crops	2 (1+1)

Floriculture and Landscaping

15.	Turf management	2 (1+1)
16.	Protected Cultivation of Flower Crops	3 (2+1)
17.	Value Addition in Floriculture	3 (2+1)
18.	Breeding of Ornamental Crops	3 (2+1)
19.	Principles of Landscape Architecture	3 (2+1)
20.	Commercial Floriculture and Landscaping	3 (2+1)
21.	Postharvest handling of Floricultural Crops	3 (2+1)

Note: The University/ Institute may offer more electives/courses relevant to the subject.

Fruit Science

Production Technology of Tropical Fruit crops 3 (2+1)

Objectives

1. To teach students origin, systematics, genetic resources, botany and production of tropical fruit crops
2. To impart adequate knowledge and skill tothe students for commercial cultivation of tropical fruit crops

Theory

Importance, scope and commercial importance of tropical fruits. Distribution of tropical zones in the world and India. Origin, systematics, distribution, genetic resources, and eco-physiological requirements. Major species, commercial varieties and rootstocks. Propagation, planting, training and pruning. Nutrient and water management. crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques. Physiological disorders, major pests and diseases and their management. Industrial and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- mango, papaya, pineapple, banana, avocado, sapota, guava, jackfruit, tamarind, annonas and minor fruits of tropics viz. carambola, mangosteen, pashion fruit, bilimbi, rambutan, longan and durian.

Practical

Description and identification of species and varieties of tropical fruits. Propagation and nursery management of tropical fruit crops. Leaf sampling and nutrient analysis. Rejuvenation of old and unproductive trees. Identification and management of nutritional disorders, insect-pest and diseases. Maturity standards, harvesting, grading, packaging and storage. Visit to commercial orchards.

Suggested Readings

1. Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
2. Bose TK and Parthasarathy V A. 2022. Fruits: Tropical and Subtropical. Vol 14th edn. Daya Publishing House, New Delhi.
3. Chattopadhyay T K. 2013. A Textbook on Pomology Vol I-II. Kalyani Publications. New Delhi.
4. ICAR. 2019. Handbook of Horticulture (Vol I and II). ICAR Publications, New Delhi.
5. Mitra SK. 2021. Guava: Botany, Production and Uses. CAB International.
6. Paull R E and Duarte O. 2011. Tropical Fruits (Vol. 1&2). CAB International.
7. Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International.

Production Technology of Sub tropical and temperate Fruit crops 3 (2+1)

Objectives

1. To familiarize the students about cultural and management practices of fruit crops
2. To impart a comprehensive knowledge and skills on quality production of fruit crops

Theory

Importance, scope and commercial importance of sub-tropical and temperate fruits. Distribution of sub-tropical and temperate zones in the world and India. Origin, systematics, distribution, genetic resources, and eco-physiological requirements. Major species, commercial varieties and rootstocks. Propagation, planting and HDP, training and pruning and orchard floor management. Nutrient and water management, flowering and fruit set, compatibility, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques. Physiological disorders, major pests and diseases and their management. Industrial

and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- citrus, grapes, pomegranate, litchi, loquat, grapes, litchi, pomegranate, apple, pear, peach, plum, apricot, cherries, berries, persimmon, kiwifruit, walnut, almond, pecan nut, hazelnut, chestnut, strawberry.

Practical

Description and identification of varieties based on flower and fruit morphology of sub-tropical and temperate fruits. Canopy management. Selection of site and planting system, Mulching, Manure and fertilizer application including bio-fertilizers in fruit crops. Preparation and application of growth regulators. Crop regulation, maturity indices, ripening of fruits, grading and packaging. Production economics of sub-tropical and temperate fruits. Visit to commercial orchards and diagnosis of maladies.

Suggested Readings

1. Chadha KL and Shikhamany SD 1999. The Grape - Improvement, Production and Post-Harvest Management. Malhotra Book Depot, New Delhi.
2. Chattopadhyay T K. 2013. Text book on Pomology (Temperate Fruits), Volume IV. Kalyani Publishers, New Delhi.
3. Chattopadhyay T K. 2013. Text book on Pomology (Sub Tropical Fruits), Volume III. Kalyani Publishers, New Delhi.
4. Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
5. Jackson D. Thiele G, Looney N E and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International.
6. ICAR. 2019. Handbook of Horticulture (Vol I and II). ICAR Publications, New Delhi.
7. Sandhu S and Gill B S. 2013. Physiological disorders of fruit crops. NIPA, New Delhi.
8. Sharma R R and Krishna H. 2018. Textbook of temperate fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.

Breeding of Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about the breeding objectives and methods of fruit breeding in a prescribed manner
2. To familiarize students with latest principles and practices of crop improvement in different fruit crops

Theory

Fruit breeding-history, importance in fruit production; Major problems in fruit breeding; Plant genetic resources, their conservation and utilization in fruit crops; Breeding objectives for improvement of commercial fruits (mango, citrus, guava, banana, grapes, strawberry, litchi, sapota, pomegranate, pineapple, papaya, apple, pear, peach, plum, cherry, kiwifruit, walnut, apricot, plantation crops-coconut, cocoa, tea, arecanut, coffee), their distribution, domestication and adaptation; Incompatibility, sterility, parthenocarpy and apomixes; Breeding methods- introduction, colonal selection, hybridization, mutation breeding, polyploid manipulation; Rootstock breeding

and improvement of quality traits; Breeding for insect-pest and disease resistance and abiotic stresses; Biotechnological interventions in fruit crop improvement.

Practical

Tools and equipment of use in fruit breeding; Studies on bearing habits and flower structure; in-vitro pollen germination test and determination of pollen viability; Methods of emasculation and pollination; Hybrid seed collection, extraction and storage; hybrid seed germination; Raising and evaluation of segregating populations; Induction of mutations through use of physical/chemical mutagens; Polyploidy manipulation; Hand on practice of Emasculation and pollination in major crops of the region.

Suggested Readings

1. Badenes, M. L. and Byrne, D. H. 2012. Fruit Breeding. Springer Science, New York.
2. Dinesh, M.R. and Sankaran, M. 2022. Fruit Breeding and Genetics, New India publishing Agency, New Delhi
3. Kumar, N. 2014. Breeding of Horticultural Crops: Principles and Practices. NIPA, New Delhi.
4. Ray. P. K. 2002. Breeding Tropical and Subtropical Fruits. Narosa Publ. House, New Delhi.
5. Ghosh, S. N., Verma, M. K. and Thakur, A. 2018. Temperate Fruit Crop Breeding: domestication to Cultivar Development. NIPA, New Delhi.

Canopy management in Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about manipulation of plant growth and development by employing different training and pruning procedures
2. To familiarize student with scientific principles of tree growth, physiology and understanding of tree response to various pruning cuts.

Theory

Introduction and importance of canopy management, objectives of canopy management, importance and factors affecting canopy development. Canopy types, tree architecture and different conventional and trellis training systems. Canopy manipulation for optimum utilization of light and its interception. Dwarfing physiology and high-density planting. Physical manipulation and growth regulation: Canopy management through rootstock and scion. Effect of thinning and heading cuts on branch growth. Canopy management through plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality in different deciduous and evergreen fruits.

Practical

Study of different types of canopies, training of plants for different canopy types, Canopy development through pruning, study of different trellis training systems, development of effective canopy with support system, study on effect of different canopy types on production and quality of fruits understanding bearing behaviour and canopy management in different fruits, use of plant growth regulators, effect of pruning on light interception and fruit quality. Canopy management practices in different deciduous and evergreen fruits.

Suggested Readings

1. Bakshi JC, Uppal DK and Khajuria HN. 1988. The pruning of fruit trees and vines. Kalyani Publishers, New Delhi.
2. Chadha KL and Shikhamany SD.1999.The Grape: improvement, production and post-harvest management Malhotra Publishing House, Delhi.
3. Iyer CPA and Kurian R M. 2006. High density planting in tropical fruits: Principles and Practices. IBDC Publishers, New Delhi.
4. Pradeep Kumar, T. 2008. Management of horticultural crops. NIPA, New Delhi.
5. Singh G. 2010. Practical manual on canopy management in fruit crops. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi.
6. Srivastava K K. 2012. Canopy management in fruits. ICAR, New Delhi.

Biotechnological Approaches and Micro propagation in Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about the biotechnological interventions and micropropagation methods in a prescribed manner
2. To familiarize students with biotechnological tools in fruit crops to enhance yield, biotic and abiotic stress management and improved quality traits to a considerable extent

Theory

Introduction, history and basic principles of biotechnology; Physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; *In vitro* culture and hardening: callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Hardening and ex vitro establishment of tissue cultured plants; Transgenics and Gene Technologies; Somatic cell hybridization, construction and identification of somatic hybrids and cybrids, wide hybridization; *In-vitro* pollination and fertilization, haploids, in vitro mutation, artificial seeds, cryopreservation: *In- vitro* selection for biotic and abiotic stress; use of molecular markers and genomics; Gene silencing, gene tagging, gene editing, achievements of biotechnology in fruit crops.

Practical

An exposure to low cost, commercially operated and privately-owned tissue culture laboratories; Tasks include preparing media, inoculating explants for clonal multiplication, inducing and culturing callus, and regenerating plantlets from callus; Methods for sub-culturing on anther, ovule, embryo culture, and somaclonal variation; *In vitro* mutant selection against abiotic stress; Protoplast culture and fusion process. Development of large-scale mass multiplication; Project development for the establishment of a commercial tissue culture laboratory.

Suggested readings

1. Bajaj YPS. 1989. Biotechnology in agriculture and forestry. Vol. V, Fruits. Springer, USA.
2. Brown T A. 2001. Gene cloning and DNA analysis and introduction. Blackwell Publishing, USA.

3. Chahal GS and Gosal SS. 2010. Principles and procedures of plant breeding: biotechnological and conventional approaches. Narosa, New Delhi.
4. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. NIPA, New Delhi.
5. Miglani GS. 2016. Genetic Engineering – principles, procedures and consequences. Narosa Publishing House, New Delhi.

Production Technology of Arid Fruit Crops 3 (2+1)

Objectives

1. To impart basic knowledge about the arid fruit crops
2. To familiarize students with the latest developments and trends in production technology of important arid fruit crops

Theory

Importance, scope and limitations of arid and semi-arid zones, Distribution of Agro-climatic arid and semi-arid zones, soil and water conservation methods-terraces, contour bunds etc. Methods of control and impounding of run-off water - farm ponds, trenches, macro catch pits etc. *In-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti transpirants, growth regulators, etc. micro systems of irrigation etc. Characteristic feature of arid fruit crops, bearing habit, flowering and fruit set, improved varieties, planting techniques, propagation, canopy management, nutrient and weed management, Special production problems, insect-pests, diseases and their control measures, Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops: ber, aonla, pomegranate, jamun, bael, date palm, phalsa, fig, custard apple, karonda, prickly pear, lasora, sea buckthorn, pistachio and wood apple

Practical

Identification of various arid fruit crops, Planning and layout of orchards, propagation methods in arid fruit crops, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, leaf sampling and nutrient analysis, preparation and application of growth regulators, layout of different irrigation systems, Identification and management of nutritional disorders, insect-pest and disease management, maturity standards, harvesting, grading, packaging and storage.

Suggested Readings

1. Chattopadhyay T K 2013. A Textbook on Pomology Vol I-IV. Kalyani Publications. New Delhi.
2. Hiwale S 2015. Sustainable Horticulture in Semiarid Drylands. Springer.
3. ICAR 2019. Handbook of Horticulture (Vol I and II). ICAR Publications. New Delhi.
4. Krishna H and Sharma R R 2017. Fruit Production- Minor Fruits. Daya Publishing House, Delhi.
5. Peter K V 2010. Underutilized and Underexploited Horticultural Crops. NIPA, New Delhi.
6. Saroj P L and Awasthi O P 2005. Advances in Arid Horticulture, Vol II: Production Technology of Arid and Semiarid Fruits. IBDC, Lucknow.

7. Sontakke M B 2014. Production and Management of Fruit Crops in Arid/Drylands. Agrotech Publishing Academy, Udaipur (Rajasthan).

Postharvest Management of Fruit crops 2 (1+1)

Objectives

1. To provide knowledge about various physico-chemical changes occurring during postharvest life of fruits

2. To familiarize students with various techniques to minimize postharvest losses and maintain the postharvest quality of fruits

Theory

Importance and scope. Maturity indices, harvesting practices and grading. Influence of pre-harvest practices. Physiology and biochemistry of fruit ripening, ethylene evolution and its management. Pre-cooling. Factors leading to post-harvest losses. Treatments prior to transportation viz. chlorination, waxing, chemicals, natural plant products, hot-water, vapour heat treatment, sulphur fumigation and irradiation. Fruit packaging and transport. Methods of storage.

Practical

Analyzing maturity stages of commercially important fruit crops, harvesting methods, pre-cooling methods, grading. Components of cold and ripening chambers. Ripening of fruits. Pre-harvest and post-harvest application of growth substances, fungicides, nutrients, waxes and hot water treatments. Improved packing and storage of important horticultural commodities, Physiological loss in weight of fruits. Estimation of quality characteristics viz; TSS, titratable acidity, firmness, Vitamin C, sugars in stored fruits.

Suggested Readings

1. Kader A A. 2002. Postharvest technology of horticultural crops. 3rd edn, University of California, Agricultural and Natural Resources.
2. Wills R, McGlasson B, Graham D and Joyce DC. 2007. An introduction to the physiology and handling of Fruits, Vegetables and ornamentals, CAB International
3. Saraswathy S, Preethi TL, Balasubramanyam S, Suresh J, Revathy N and Nararajan S. 2010. Postharvest management of horticultural crops. Agrobios publication, Jodhpur.
4. Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables. Vol I and II

Vegetable Science

1.	Production Technology of Warm Season Vegetable Crops	3 (2+1)
2.	Production Technology of Cool Season Vegetable Crops	3 (2+1)
3.	Production Technology of Tuber Crops	3 (2+1)
4.	Breeding of Vegetable Crops	3 (2+1)
5.	Biotechnological Approaches and Micropropagation in Vegetable Crops	3 (2+1)
6.	Postharvest Management of Vegetable Crops	3 (2+1)
7.	Protected Cultivation of Vegetable Crops	2 (1+1)

Note: ***The University/ Institute may offer more electives/courses relevant to the subject.***

Production Technology of Warm Season Vegetable Crops 3 (2+1)

Objectives

To impart knowledge and skills for production of warm season vegetable crops

Theory

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids, sowing/ transplanting time, seed rate, seed treatment, nutritional and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, postharvest management, plant protection measures and seed production of warm season vegetable crops i.e. solanaceous crops, okra, cucurbitaceous crops, cowpea, sweet potato, cluster beans, amaranth, basella, moringa, tapioca. Poly-house, net- house and low tunnel technology for off-season production of summer vegetables

Practical

Seed extraction, sowing practices, nursery management, Use of growth regulators, grafting technique, water and nutrient management. Drip irrigation, fertigation, weed management and mulching. Identification of physiological disorders, pests, diseases and nutrient deficiencies. Study of maturity indices. Forcing techniques for raising summer vegetables. Visit to vegetable nursery unit/ protected cultivation unit.

Suggested readings

1. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya Udyog.
2. Dhaliwal M S. 2017. Handbook of Vegetable Crops. Kalyani publishers, Ludhiana
3. Hazra P. 2016. Vegetable science. 2nd Ed, Kalyani publishers, Ludhiana.
4. Hazra P. 2019. Vegetable production and technology. New India Publishing Agency, New Delhi.
5. ICAR. 2002. Hand Book of Horticulture. ICAR.
6. Thamburaj S and Singh N (Eds). 2004. Vegetables, tuber crops and spices. ICAR.

Production Technology of Cool Season Vegetable crops 3 (2+1)

Objectives

To impart knowledge and skills for production of cool season vegetable crops

Theory

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids evolved by private and public sector, sowing/ transplanting time, seed rate and seed treatment, nutritional and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, postharvest management, plant protection measures and seed production of

potato, cole crops; cabbage, cauliflower, knolkhol, broccoli, brussels' sprout, chinese cabbage, root crops; carrot, radish, turnip, beet root, bulb crops; onion and garlic, peas and beans, green leafy cool season vegetables.

Practical

Seed extraction, sowing practices, nursery management, Use of growth regulators, grafting technique, water and nutrient management. Drip irrigation, fertigation, weed management and mulching. Identification of physiological disorders, pests, diseases and nutrient deficiencies. Study of maturity indices. Forcing techniques for raising cool season vegetables. Visit to vegetable nursery unit/ protected cultivation unit. Layout of kitchen garden.

Suggested Readings

1. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya Udyog.
2. Dhaliwal M S. 2017. Handbook of Vegetable Crops. Kalyani publishers, Ludhiana
3. Hazra P. 2016. Vegetable science. 2nd edn, Kalyani publishers, Ludhiana.
4. Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
5. ICAR. 2002. Hand Book of Horticulture. ICAR.
6. Thamburaj S and Singh N (Eds). 2004. Vegetables, tuber crops and spices. ICAR.

Production Technology of Tuber crops 3 (2+1)

Objectives

To impart knowledge and skill for production of tuber crops and their management

Theory

Origin, area, production, economic importance and export potential of tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices yield; economic of cultivation. Postharvest handling and storage, marketing. Crops to be covered-potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish, coleus and yam bean and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, postharvest handling and storage, marketing. Seed collection, working out cost of cultivation.

Suggested Readings

1. Dhaliwal M S. 2008.Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana

2. ICAR. 2002. Hand Book of Horticulture. ICAR.
3. Thamburaj S. 2014. Text book of vegetable, tuber crops and Spices. ICAR, New Delhi.
4. Umashankar. 2008. Indian Vegetables. Anmol Publications. Pvt. Ltd., New Delhi.

Breeding of Vegetable crops 3 (2+1)

Objectives

1. To make students well verse with the plant genetic resources and their utilization in improvement of vegetable crops
2. To impart knowledge and skill regarding breeding procedures of self-pollinated, often cross pollinated, cross-pollinated and vegetatively propagated vegetable crops

Theory

Definition and history of vegetable breeding. Origin, distribution, wild relatives and breeding objective of different vegetable crops viz. tomato, brinjal, chilli, muskmelon, watermelon, cucumber, bitter gourd, pumpkin, squashes, onion, garlic, carrot, radish, cauliflower, cabbage, pea, okra and potato. Plant genetic resources, their utilization and conservation. Breeding procedures of self-pollinated, often cross pollinated, cross-pollinated and vegetatively propagated vegetable crops. Conventional and modern techniques for improvement of vegetable crops. Breeding for biotic, abiotic stress tolerance and quality in vegetable crops. Genetic mechanisms for exploitation of heterosis in vegetable crops.

Practical

Study of inflorescence and flower structures. Practice for emasculation and artificial pollination. Distinguished morphological characteristics of released varieties/hybrids. Layout of field experiments. Estimation of heterosis. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods. Visit to vegetable seed production field.

Suggested readings

1. Allard RW. 1960. Principle of plant breeding. John Willey and Sons, USA.
2. Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.
3. Kole CR. 2007. Genome mapping and molecular breeding in plants-vegetables. Springer, USA.
4. Peter KV and Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488.
5. Prohens J and Nuez F. 2007. Handbook of plant breeding-vegetables (Vol I and II). Springer, USA.
6. Ram H H. 2019.Vegetable Breeding: Principles and Practices. Kalyani Publishers.
7. Singh BD. 2007. Plant breeding- principles and methods. 8th edn. Kalyani Publishers, New Delhi.
8. Singh Ram J. 2007. Genetic resources, chromosome engineering, and crop improvement-vegetable crops (Vol. 3). CRC Press, Fl, USA.
9. Swarup V. 2016.Vegetable Science and Technology in India. Kalyani Publishers.

Biotechnological Approaches and Micropropagation in Vegetable crops 3 (2+1)

Objectives

To educate students about latest biotechnical advancements in vegetables

Theory

Concepts and applications of plant biotechnology. Introduction to recombinant DNA methods: physical, chemical and Agrobacterium mediated gene transfer methods; Transgenics and its importance in crop improvement; PCR techniques and its applications; DNA markers and their application - RFLP, RAPD, AFLP, CAPS, SSR etc. Marker Assisted Breeding in crop improvement; Biotechnology regulations. Plant Cell and Tissue Culture - organ culture, embryo culture, cell suspension culture, protoplast culture, callus culture, anther culture, pollen culture, ovule culture and their applications; Micro-propagation methods; organogenesis and embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance. Somatic hybridization and cybrids. Soma-clonal variation and its use in crop improvement. Cryo-preservation. Application of *in-vitro* techniques.

Practical

Preparation of solution, pH and buffers. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants and plant regeneration. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA and PCR technique. Demonstration of gel electrophoresis techniques and DNA finger printing.

Suggested Readings

1. Bajaj YPS (Ed.). 1987. Biotechnology in agriculture and forestry. Vol. XIX. Hitech and Micropropagation. Springer.
2. Chadha KL, Ravindran PN and Sahijram L (Eds). 2000. Biotechnology of horticulture and plantation crops. Malhotra Publ. House.
3. Debnath M. 2005. Tools and techniques of biotechnology. Pointer publication, New Delhi. Horticultural Sciences–Vegetable Science
4. Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New India Publ. Agency.
5. Keshavachandran R and Peter KV. 2008. Plant biotechnology; tissue culture and gene transfer. Orient and Longman, USA.
6. Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New-India Publication Agency, New Delhi.
7. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology of horticultural crops. Vols. I-III. Naya Prokash. Pierik RLM. 1987. In-vitro culture of higher plants. Martinus Nijhoff Publ.
8. Prasad S. 1999. Impact of plant biotechnology on horticulture. 2nd edn. Agro Botanica.
9. Rout GR and Peter KV. 2018. Genetic engineering of horticultural crops. Academic Press Elsevier, USA.

10. Sharma R. 2000. Plant tissue culture. Campus Books.
11. Singh BD. 2010. Biotechnology- expanding horizons. Kalyani Publishers, New Delhi.
12. Vasil TK, Vasi M, While DNR and Bery HR. 1979. Somatic hybridization and genetic manipulation in plants, plant regulation and world agriculture. Planum Press.

Postharvest Management of Vegetable Crops 3 (2+1)

Objectives

To understand pre- and post-harvest factors responsible for deterioration in vegetable crops

Theory

Determination of maturity in different vegetable crops, assessment of post-harvest losses, pre-harvest methods and practices affecting post-harvest shelf life of vegetables, mechanized harvesting of vegetables, pre-cooling of vegetables using different techniques, post-harvest chemical and non-chemical treatments to enhance shelf life, sorting and grading for packaging, ripening of vegetables, packaging of vegetables including latest techniques like MAP, storage of vegetables including latest techniques like CA storage, food safety and quality, non-destructive methods of quality analysis, quality of raw material for processing, transportation and destination handling, marketing, treatments before shipment and storage, fresh-cut vegetables.

Practical

Practices in judging the maturity of vegetables, harvesting methods and tools. Methods used for pre-cooling and their efficiency measurements. Post-harvest chemical treatments to extend shelf life. Sorting and grading methods. Ripening techniques used in climacteric vegetables. Traditional and latest safe storage techniques. Respiration measurements in harvested produce. Field visit to post-harvest and processing industry.

Suggested Readings

1. Chadha KL and Pareek OP. 1996. Advances in horticulture. Vol. IV. Malhotra Publ. House.
2. Chattopadhyay SK. 2007. Handling, transportation and storage of fruit and vegetables. Gene Tech books, New Delhi.
3. Haid NF and Salunkhe SK. 1997. Postharvest physiology and handling of fruits and vegetables. Grenada Publ.
4. Mitra SK. 1997. Postharvest physiology and storage of tropical and sub-tropical fruits. CABI.
5. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest biology and technology of Fruits, vegetables and flowers. Wiley-Blackwell, ISBN: 9780813804088.
6. Ranganna S. 1997. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill.
7. Stawley JK. 1998. Postharvest physiology of perishable plant products. CBS publishers.
8. Sudheer KP and Indira V. 2007. Postharvest technology of horticultural crops. New India Publ. Agency.
9. Thompson AK (Ed.). 2014. Fruit and vegetables: harvesting, handling and storage (Vol. 1 and 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.

10. Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables: handling, processing, fermentation and waste management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
11. Willis R, McGlassen WB, Graham D and Joyce D. 1998. Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI.
12. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
13. Wills RBH and Golding J. 2017. Advances in postharvest fruit and vegetable technology, CRC Press, ISBN 9781138894051

Protected Cultivation of Vegetable crops **2 (1+1)**

Objectives

To provide technical know-how to students for raising vegetables under protected structures

Theory

Protected cultivation- importance, scope and constraints, status of protected cultivation in India and world. Soil/substrate preparation and management. Classification and types of protected structures. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops viz., tomato, bell pepper, cucumber, lettuce, brinjal. Off season production of vegetables. Hydroponics, aeroponics system of cultivation, Insect pest and disease management. Use of protected structures for seed production; Economics of greenhouse crop production

Practical

Identification of different protected structures, Use of pro-trays in quality planting material production, Identification of different growing media/ substrates, Raising of seedlings and saplings under protected cultivation, Bed preparation, planting and intercultural operations for crop production, Estimation and management of soil EC, Estimation and management of pH in media/ substrates, Scheduling of irrigation in different horticultural crops, Fertilizer management through drip irrigation, Control of disease and insect pests in protected structures, fumigation techniques. Visit to commercial protected cultivation units.

Suggested Readings

1. Chandra S and Som V. 2000. Cultivating vegetables in green house. Indian Horticulture 45:17-18.
2. Parvatha RP. 2016. Sustainable crop protection under protected cultivation. E-Book Springer. Prasad S and Kumar U. 2005. Greenhouse management for horticultural crops. 2nd edn. A Grobios.
3. Singh B. 2005. Protected cultivation of vegetable crops. Kalyani publishers, New Delhi.
4. Singh DK and Peter KV. 2014. Protected cultivation of horticultural crops (1st edn). New India Publishing Agency, New Delhi.
5. Singh S, Singh B and Sabir N. 2014. Advances in protected cultivation. New India Publishing Agency, New Delhi.
6. Tiwari GN. 2003. Green house technology for controlled environment. Narosa publ. house.

Semester VII

List of Elective courses

Floriculture and Landscaping

1.	Turf Management	2 (1+1)
2.	Protected Cultivation of Flower Crops	3 (2+1)
3.	Value Addition in Floriculture	3 (2+1)
4.	Breeding of Ornamental Crops	3 (2+1)
5.	Principles of Landscape Architecture	3 (2+1)
6.	Commercial Floriculture and Landscaping	3 (2+1)
7.	Postharvest Handling of Floriculture Crops	3 (2+1)

Note: ***The University/ Institute may offer more electives/courses relevant to the subjects.***

Turf Management 2 (1+1)

Objectives

1. To impart hands-on training on practical aspects of turf management practices
2. To impart entrepreneurial skills in turf establishment

Theory

History, present status and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality. Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens. Turf establishment methods such as seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, instant turfing (portable), hydro-seeding, Turf management – Irrigation, drainage, nutrition, special practices like aerating, rolling, coring, dethatching, verti-cutting, soil topdressing, use of plant growth regulators and micronutrients, Turf mowing – mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water etc., Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, residential and public parks, turfing of Govt. and Corporate office gardens, turf colourants.

Practical

Identification of turf grasses and turf machinery, Soil preparation, turf establishment methods, provision of drainage, Layout of macro and micro irrigation systems, Water and nutrient management, Special practices – mowing, raking, rolling, soil top dressing, weed management, Biotic and abiotic stress management, Project preparation for turf establishment, Visit to parks and golf courses, corporate, Govt. organizations, Rejuvenation of lawns, Turf economics.

Suggested Readings

1. Jankiram, T, Namita and Jain Ritu. Introduction to Turfgrasses. 2015. 1st edn. Westville publishing house.

2. Nick E. 2016. Christians Fundamentals of Turfgrass Management. 5th edn, Aaron J. Patton, Quincy D. Law. Published by Wiley
3. Tiwari A K, Singh, K P, Shephalika Amrapali, Girish, K S and Singh Premjit. 2015. Lawn Management. ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India 1-48.

Protected Cultivation of Flower Crops 3 (2+1)

Objectives

1. To enable regulation of flowering under protected cultivation
2. To impart skills in formulating the project on protected cultivation of flower crops

Theory

Prospects and types of protected structures: Prospects of protected floriculture in India; Types of protected structures – Glasshouse/polyhouse, shade net houses, mist chambers, lath houses, orchidarium, fernery, rain shelters etc. Principles of designing and erection of protected structures; Low cost/Medium cost/High-cost structures; Structural components; Suitable flower and foliage plants for protected cultivation. Microclimate management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation, containers and substrates, media, soil decontamination, layout of drip and fertigation system, water and nutrient management, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation. Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, Export standards, MDH guidelines for erection of protected structure, APEDA regulations for export. Crops: Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Lilium, Alstromeria, etc.

Practical

Study of various protected structures, Design, layout and erection of different types of structures, Practices in preparatory operations, growing media, soil decontamination techniques, Microclimate management, Practices in drip and fertigation techniques, special horticultural practices, Determination of harvest indices and harvesting methods, Postharvest handling, packing methods, Economics of cultivation, Project preparation, Project Financing guidelines, Visit to commercial greenhouses.

Suggested Readings

1. Tyagi S and Sahay S 2020. Protected cultivation of flowers 2020 NIPA, New Delhi.
2. Singh Mahesh Chand and Sharma, K K. 2024. Protected Cultivation: Structural design, crop management, modelling and automation. CRC Press.

Value Addition in Floriculture 3 (2+1)

Objectives

1. To study different methods of value addition like drying, flower arrangements, oil extraction, etc.
2. To prepare value added products from flower crops

Theory

Scope and prospects of value addition, Types of value-added products, techniques of value addition including tinting. Value addition in loose flowers and product development- Gulkhand, floral tea, rose oil, rose water, Pankhuri, floral dyes, rose sherbet, floral ice creams, sweets, etc. Flower arrangement, styles, ikebana schools (ikenobo, ohara, sogetsu etc), Ikebana- moribana, nagiere, contemporary style. Dry flowers– Identification and selection of flowers and plant parts; tips for collecting dry flower making, selection of stages for picking of flowers for drying, Techniques in dry flower making – Drying, glycerising, bleaching, dyeing, embedding, pressing; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; petal embedded handmade papers. Post drying management including moisture, pests and molds. Essential oils; Selection of species and varieties (including nonconventional species), extraction methods, Packing and storage, Aromatherapy. Types of pigments, carotenoids, anthocyanins, chlorophyll, betalains; Significance of natural pigments as nutraceuticals, Extraction methods and applications in food, pharmaceutical and poultry industries. Synthetic and Natural dyes, dying techniques, colour retention.

Practical

Practices in preparation of different type of flower arrangements including bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers, Techniques in flower arrangement and floral decoration, Identification of plants for dry flower making, Practices in dry flower making; Preparation of dry flower baskets, bouquets, potpourri, wall hangings, button holes, greeting cards, wreaths, etc. Essential oil extraction units, Extraction of pigments, Visit to dry flower units, Economics of value-added products.

Suggested Readings

1. De LC. 2019. Value Addition in Flowers and Orchids- New India Publishing Agency.
2. Gupta Sachi, Pathak Sanjay and Yadav Atul. 2019. Advances and value addition in flower crops. Weser Books.

Breeding of Ornamental crops 3 (2+1)

Objectives

1. To teach the students crop specific breeding
2. To teach the students about the varieties evolved in flower crops through various methods and institutions

Theory

Origin, evolution, distribution, introduction, domestication and conservation of ornamental crops. Unit II: Introduction and initiatives in IPR and PBR of ornamental crops. Breeding objectives, reproductive barriers (Male sterility, incompatibility) in major ornamental crops. Inheritance of important traits, Genetic mechanisms associated with flower colour, size, form, doubleness, fragrance, plant architecture, post-harvest life, abiotic and biotic stress tolerance/ resistance. Breeding methods suitable for sexually, asexually propagated flower crops, self- and cross- pollinated crops-pedigree selection, backcross, clonal selection, polyploidy and mutation breeding, heterosis and F1

hybrids. Role of biotechnology in improvement of flower crops including somaclonal variation, in vitro mutagenesis, genetic engineering, molecular markers etc., Crops- rose, chrysanthemum, carnation, gerbera, gladiolus, orchids, anthurium, lilium, marigold, jasmine, tuberose, dahlia, gaillardia, crossandra, aster etc., Flowering annuals: petunia, zinnia, snapdragon, stock, pansy, calendula, balsam, dianthus etc. Important ornamental crops like aglaonema, diffenbachia, hibiscus, bougainvillea, tecoma, kalanchoe etc.

Practical

Floral biology of important ornamental crops, Cytology and cytogenetics. Selfing and crossing procedures for important ornamental crops. Evaluation of hybrid progenies. Induction of mutants through physical and chemical mutagens. *In vitro* selection, genetic engineering. Induction of polyploidy. DUS testing.

Suggested Readings

1. De LC. 2019. Ornamental Crop Breeding. Aavishkar Publishers and Distributors, Jaipur, Rajasthan.
2. Singh BD. 2006. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.

Principles of Landscape Architecture 3 (1+2)

Objectives

1. To familiarize students with basics of Auto-CAD software
2. To impart skills in preparation of garden designs

Theory

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc. Elements of landscape gardens. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, countryside planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway stations, factories, bus stands, air ports corporate buildings, river banks, play grounds.

Practical

Study of gardens, tools and implements. Use of drawing equipment, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, religious places, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

Suggested readings

1. Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edn, pp.230.
2. Randhawa, G. S. and Mukhopadhyay, A. 2001. Floriculture in India. Allied Publishers, pp 660.

Commercial Floriculture and Landscaping 3 (2+1)

Objectives

- To learn about production technology, propagation, and cultural practices and packaging and marketing of various flower crops
- To learn generating the planting material and their practical use in different landscaping projects

Theory

Scope, importance and export potential of floriculture, environment factors influencing plant growth and flower production in cut flowers and cut greens. Production technology including varieties, propagation, soil, nutrition, disease and pests of important cut flowers. Post harvest handling, grading and packing cut flowers, pot and bedding plants. Flower seed production. Cost of production of commercially important flowers. History of gardening, characteristics of Hindu, Mughal, Japanese and English gardens. Principle groups of plants like trees, shrubs, climbers, shade loving plants, ground covers, their analysis and use in landscape composition. Principles of art and landscaping. Preparation of landscape plans for homes, farm complexes, small parks and institutions. Development and maintenance of rock, water and terrace gardens. Bonsai and dish gardens, project formulation and evaluation.

Practical

Preparation of plans and laying out of gardens. Identification of planting material and commercial varieties of flowers. Seed collection, germination tests and storage. Harvesting and handling of cut flowers. Judging of flowers and pot plants. Visit to local nurseries and florist centers.

Suggested readings

1. Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edn, pp. 230.
2. Randhawa, G. S. and Mukhopadhyay, A. 2001. Floriculture in India. Allied Publishers. pp 660.

Postharvest handling of Floriculture crops 3 (2+1)

Objectives

1. To teach the students about various factors leading to postharvest losses in flowers
2. To acquaint the students about various technologies (like conditioning, grading, storage, packaging etc) used in postharvest management of flowers
3. To provide hand on training to students for postharvest handling of commercial flowers

Theory

Importance of Postharvest Technology in Floricultural crops, Physiology of flowering in relation to photoperiodism, temperature and other environmental factor. Structural, biochemical,

metabolic and hormonal changes during flower senescence. Factors affecting postharvest quality of flowers- pre harvest, harvest and postharvest. Causes of decline in post-harvest life of flowers. Floral preservatives - holding, pulsing and budding. Plant hormones and their role in postharvest management of flowers. Storage, its types and factors affecting storage. Grading of different flowers. Packaging – passive and active. Importance of cool chain in transportation of cut flowers. Physiological disorders of flowers. Latest approaches to improve postharvest life of flowers. Postharvest handling of commercial flowers- Rose, Chrysanthemum, Gladiolus, Lilium Tuberose and marigold.

Practical

Photoperiodism and vernalization in flowering. Membrane integrity and water relation during senescence. Harvest and postharvest factors affecting postharvest quality of flowers. Preparations of different solutions. Holding and pulsing solutions. Wet and dry storage. Grading of flowers. Types of packaging. Physiological disorders of flowers and their remedial measures. Postharvest handling of commercial flowers- Rose, Chrysanthemum, Gladiolus, Lilium Tuberose and marigold.

Suggested Readings

1. Bhattacharjee, SK and De, LC. 2004. Advances in Ornamental Horticulture Vol. V, Pointer publishers, Jaipur.
2. Bose, TK and Yadav, LP. 1989. Commercial Flowers. Naya Prokash, Kolkata.
3. Bose, TK, Maiti, RG, Dhua, RS and Das, P. 1999. Floriculture and Landscaping. Naya Prokash.
4. Larson, RA and Armitage, AM. 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow, India.
5. Nowak, J and Rudnicki, RM. 1990. Postharvest handling and storage of cut flowers, florist greens, and potted plants. Timber Press, USA. pp. 210.

SKILL ENHANCEMENT COURSES (SEC)

S. No.	Course Title	Credit Hours
	First Year	
SEC-I (any of two courses can be selected)		
1.	Mushroom Cultivation	2 (0+2)
2.	Apiculture	2 (0+2)
3.	Orchard Floor Management	2 (0+2)
4.	Landscape Gardening	2 (0+2)
SEC- II (any of two courses can be selected)		
5.	Packing and Packaging of Horticulture Crops	2 (0+2)
6.	Farm Machinery	2 (0+2)
7.	Introduction to Forestry	2(0+2)
8.	Installation, Operation and Maintenance of Micro-irrigation System	(0+2)

S. No.	Course Title	Credit Hours
	Second Year	
SEC- III (any of one course can be selected)		
9.	Computer Programming and Data Structures	(0+2)
10.	Turf and Turf Management	(0+2)
11.	Post-harvest management of Horticulture Produce	(0+2)
SEC- IV (any of one course can be selected)		
12.	Nursery Production in Horticulture Crops	(0+2)
13.	Seed Production techniques in Vegetable Crops	(0+2)
14.	Sericulture	(0+2)

1. Mushroom Cultivation (0+2)

Current status and scope of mushroom cultivation in India and Punjab, Important features of edible fungi, Nutritional and medicinal value of mushrooms, Preparation of media, Tissue culture preparation, Sub-culturing for culture maintenance and its preservation, Spawn preparation techniques, Collection of wild mushroom flora of Punjab, Raw material formulations for Agaricus bisporus (button mushroom), Composting (long method and short method), Casing preparation, Crop management practices, Mushroom farm design and infrastructure required for commercial unit, Cultivation techniques of *Pleurotus florida* (dhingri), *Lentunus edodes* (shiitake), *Calocybe indica* (milky) and *Volvoriella volvacea* (paddy straw) mushrooms, Marketing of mushrooms, Mushroom diseases and their control, Preparation of value added products from mushrooms, Economics of mushrooms, Exposure visit to commercial farms.

2. Apiculture (0+2)

Identification of honeybee species and castes. Hive and other apicultural appliances. Examination of honeybee colonies. Recording of colony performance. Bee pasturage. Migratory routes and migration of colonies. Seasonal management of honeybee colonies. Selection of honeybee colonies for improving bee health and colony productivity. Mass queen bee rearing techniques. Identification of bee enemies and diseases and their management. Foraging and communication behaviour in honeybees. Honey extraction, processing and packaging. Collection of other hive products.

3. Orchard Floor Management (0+2)

Layout of different systems of orchards and Fruit Nutrition Garden. Soil management practices: clean cultivation, sod culture, sod mulch, intercropping, cover cropping and mixed cropping. Use of mulch materials: organic and inorganic, moisture conservation and weed control. Layout of various irrigation systems, surface irrigation: Flood system, basin system, modified basin system, furrow method, sub-surface irrigation systems: drip irrigation and its components, overhead irrigation: sprinkler system, fertigation, Different methods of application of manure and fertilizers, use of organic manures, Biofertilizers, Green manuring and bio-agents. Visit to orchards of Progressive fruit growers.

4. Landscape Gardening (0+2)

Identification and use of garden tools and equipment. Study of growth characters, identification and classification of ornamental trees, shrubs, climbers, ground covers and indoor plants. Making and maintenance of edge, hedge and topiary. Establishment and maintenance of a lawn. Bonsai making. Art principles of landscaping. Formal and informal gardens. Planning, designing and establishment of garden features. Landscape design process: Landscape drafting tools. Dimensioning, graphic symbols and notations. Site analysis and landscape designing of residential, public buildings and religious places. Landscape planning of roads and roundabouts. Visit to community parks and Institutional gardens.

5. Packing and Packaging of Horticulture crops (0+2)

Different packaging and cushioning materials used for horticultural produce. Packaging technology for retail marketing- vacuum, shrink wrap, cling pack. Concept of active and passive packaging. Important physical parameters of different packaging materials. Determination of gas permeability and water vapour permeability of packaging materials. Designing of retail packaging boxes. Different type of damages occurring in horticultural crops during transportation. Packaging technology for domestic and export of commercial horticultural crops. Controlled and modified atmospheric packaging for shelf-life enhancement. Visit to commercial pack house. Visit to fruits and vegetables market.

6. Farm Machinery (0+2)

Familiarization with different makes and models of agricultural tractors. Identification of various functional systems including air supply, fuel, cooling, transmission, steering and hydraulic systems. Maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Practice of driving a tractor and with tillage tools (Primary/Secondary tillage implements) and their adjustment in the field. Field patterns while operating a tillage implement. Hitching and de-hitching of mounted and trailed type implements to the tractor. Practice for driving of a trailed type of trolley: forward and in reverse direction. Familiarization with different types of sprayers. Operation of tractor operated boom and orchard sprayers. Calibration of a sprayer. Nozzle spacing on a boom, pressure setting of a nozzle. Use of Pick Positioner. Use of drones for spraying. Familiarization with tractor operated tree pruners.

7. Introduction to Forestry (0+2)

Identification of important farm grown trees, tree seeds and seedlings. Site selection for tree nursery and layout of nursery. Propagation methods, plantation establishment, plantation management, pest and diseases management and harvesting for various wood-based industries. Height measurement, diameter measurement and Volume estimation in trees - Identification of wood and non - wood forest products - Visit to Agroforestry plantations. Visit to Pulp and Paper, Matchwood, Energy, plywood industries to study the production, processing and marketing.

8. Installation, Operation and Maintenance of Micro-Irrigation System (0+2)

Micro-irrigation system installation: installation of filters and fertigation equipment, installation of main and sub mains, laying of laterals, punching of laterals, and fixing of emitters, operation of micro-irrigation systems(drip/sprinkler). Maintenance of micro-irrigation system: filter cleaning, maintenance of fertigation equipment, chemical treatment, sub-main and lateral/

bi-wall flushing. Introduction to automated irrigation system in open field and greenhouse- sensors for soil moisture, temperature, light control devices, timing devices, fertigation systems, solenoid devices, remote controlled valves system.

9. Computer Programming and Data Structures (0+2)

Introduction to high level languages; structure programming, C programming, a simple C programming, execution of a 'C' program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Creating user defined functions; Developing structures and union; Using local, global and external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/ Deletion in queues.

10. Turf and Turf Management (0+2)

Site analysis for turf establishment. Field preparation and layout for turf making. Identification and classification of turf grasses. Turf establishment methods. Sod production. Turf irrigation management. Nutrient management in turf grasses. Special practices in turf management. Rejuvenation of old and withered turf. Equipment for turf management. Selection and maintenance of grasses for Golf course and Cricket ground. Turfing for roof top gardens. Applications and use of Turf growth regulators (TGRs). Identification of seasonal turf grass weeds. Integrated approaches for turf weed management. Identification and management of Turfgrass diseases, insect-pests, abiotic stress disorders and nutrient deficiencies.

11. Post-harvest management of Horticulture Produce (0+2)

Layout and planning of postharvest experiments, Maturity and harvesting of horticulture produce. Judging maturity by different methods. Harvesting tools. Objective measurement of colour, texture and dry matter. Components and equipment used in Postharvest laboratory, Different types of cleaning agents and washing methods for horticultural produce. Layout of packhouse and General packhouse operation. Sorting, surface sanitizing and drying of fruit. Postharvest treatments for shelf-life extension of fruits and vegetables. Packing of fruits in different packaging materials, preparation of different coating materials and their method of applications. Pre-cooling of horticultural produce. Ripening technology for horticultural crops. Significance of sorting and grading in horticulture produce: Types of grading system and standards. Cold-chain management. Storage requirements. Commercial technologies for processing of horticultural produce.

12. Nursery Production in Horticulture crops (0+2)

Layout of model nursery, Tools and equipment-identification and application. Different methods of breaking seed dormancy stratification, scarification and use of plant growth regulators. Extraction and storage of healthy seeds, seed bed preparation, Identification and raising of rootstocks for different fruit plants, soil solarization, preparation of potting mixtures. Selection of healthy scion wood, practices in different methods of plant propagation like cutting, layering, budding and grafting

in fruit plants. Micropropagation-explant preparation, media preparation, culturing–meristem tip culture, axillary bud culture, micro-grafting and hardening of plants. Nursery management practices i.e. weed control, irrigation, nutrition, removal of sprouts etc. Protection of nursery plants against adverse climatic conditions. Protected structures. Diagnosis and control of important diseases and pests in the nursery, lifting and packing of nursery plants, Visit to commercial tissue culture laboratories and accredited nurseries.

13. Seed Production techniques in Vegetable crops (0+2)

Vegetable seed industry in India, Floral biology, pollination and breeding behaviour of important vegetable crops, Categories of seeds and their maintenance, Characteristics of quality seed, Agronomical principles and methods of seed production in important vegetable crops, Use of growth regulators and chemicals in vegetable seed production, Methods of hybrid seed production, Seed harvesting, extraction, curing, drying, grading, packaging and storage, Seed sampling and seed testing (genetic purity, seed viability, seedling vigour, germination, physical purity), Visit to seed processing units, seed testing laboratory and seed production farms.

14. Sericulture (0+2)

Mulberry varieties, Host plants of non-mulberry silkworms, Preparation of land, planting material and planting of mulberry, Pruning, harvesting and storage of mulberry, Mulberry pests and diseases, Identification of cocoons of important breeds, External morphology of life stages egg, larva, pupa and moth of *Bombyx mori* L. Study of silk glands and digestive system of *Bombyx mori* L. Disinfectants- rearing bed and general disinfectants, Grainage techniques. Study of rearing house plan and equipment's for shoot feeding and shelf rearing. Methods of Incubation of silkworm eggs and brushing. Identification of silkworm settling for moult, at moult, out of moult, Feeding, bed cleaning and spacing, Identification and picking of ripe silkworms, mounting, types of mountages, cocoon harvesting and grading, Pests and diseases of mulberry silkworm, Single cocoon reeling, study of reeling equipment.

ONLINE COURSES

- The students will choose 10 credit online (as per UGC guidelines for online courses) as a partial requirement for the for the B. Sc (Hons) Horticulture degree program. These can be taken any time during the whole span of the degree program as per choice of students.
- The online courses can be from any field such as Horticulture, Basic Sciences, Humanities, Economics, Business Management, Languages including foreign language, Communication Skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.
- The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.
- The courses will be non-gradial as separate certificates would be issued by institutes offering the courses.
- The MOOC courses taken by the student will be separately registered/ approved at the University level.
- The University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (satisfactorily completed) courses in final transcript issued to the student.

FOOD NUTRITION AND DIETETICS

Course Curricula For Undergraduate program in Food Nutrition and Dietetics UG- Certificate in Food Nutrition and Dietetics UG- Diploma in Food Nutrition and Dietetics B.Sc. (Hons.) Food Nutrition and Dietetics

INTRODUCTION

Food Nutrition and Dietetics is a linking discipline between agricultural food production system and human health management system. It deals with the science which manages normal nutrition and health situations of the entire population of the country. The Food Nutrition and Dietetics program has come under the umbrella of ICAR in the 5th Deans' Committee Report, and the program is currently running in 6 agriculture universities, namely, MPUA&T, Udaipur; PAU, Ludhiana; CAU, Tura; TNAU, Madurai; AAU, Assam and SDAU, Gujarat. This program was taken up by the ICAR because improvement in food production has not improved the nutrition situation among Indians. In order to meet global nutrition targets by 2030, India needs a food distribution system, nutrition education, nutritional intervention and a continuous program monitoring team. However, there is dearth of nutritionists and dieticians in country. It has been estimated by research that India lacks around 2.5 lakh dieticians. The PMO is keenly observing the nutrition situation of population and has taken out several programs like Prime Ministers Overarching Scheme for Holistic Nutrition (POSHAN Abhiyan).

To meet out the gap Government of India via, Gazette notification The National Commission For Allied And Healthcare Professions Act, 2021 identified nutritionists as "healthcare professionals", it includes a scientist, therapist or other professional who studies, advises, researches, supervises or provides preventive, curative, rehabilitative, therapeutic or promotional health services and who has obtained any qualification of degree under this Act, the duration of which shall not be less than three thousand six hundred hours spread over a period of three years to six years divided into specific semesters. Nutrition Science Professional is a person who follows a scientific process to assess, plan and implement programs to enhance the impact of food and nutrition on health, promotes good health, prevent and treat disease to optimize the health of individuals, groups, communities and populations with training in nutritional science, food science, food

quality and safety, normal and therapeutic dietetics. It includes Dietician, Clinical Dietician, Food Service Dietician, Public Health Nutritionist, Sports Nutritionist, Food Scientist, Food Safety and Quality Analyst. Keeping this in mind, this course has been developed and revised as per NEP, 2020.

The present report is an outcome of the valuable suggestions and recommendations of VI Deans' Committee members after having multistage in-depth deliberations and discussions in virtual meetings and personal communications with the Deans and faculty members. Restructuring process followed consultations with Deans of Home Science/ Community Science colleges, Heads of department of Foods and Nutrition, senior faculty members of food and nutrition, meetings with stake holders like students, industry partners, government officials, dieticians etc. After several rounds of consultations, the contents of restructured course curricula have been developed. Restructuring of Undergraduate programs in Food Nutrition and Dietetics was carried out as per National Education Policy- 2020 guidelines to build among students' strong foundation of Knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge.

Curriculum content is modified in a way to have core essentials and space is made for critical thinking based, inquiry-based, discovery-based, discussion-based, and analysis and problem solving based more holistic learning. Approach of program is for holistic development i.e. learning how to learn, to inculcate character and creating holistic and well-rounded individuals. Emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses via electives offered in fourth year and also through online courses along with provision of advanced skill development through project work or experiential learning, etc., with amalgamation of multiple exit and entry options as per NEP- 2020.

HIGHLIGHTS

- The whole course program of 4 years B.Sc. Food Nutrition and Dietetics (Hons.) will be of 177 credit hours, which will have 167 credits offered by the parent university and 10 credit hours of online courses taken by the student as per his/ her choice.
- After the admission of students in the university, the students will register for the Foundation program of 2 weeks' duration in the 1st semester. The course will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.
- Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The students will have to do common courses under following categories like Multi- Disciplinary Courses, Value Added Courses, Ability Enhancement Course, NSS/NCC etc.
- The first year of the course is dedicated for skill development in Food, Nutrition and Dietetics areas with few introductory courses. The skill enhancement courses (SEC) of 8 credit hours

will be offered during Semester-I and Semester-II of first year with flexibility to students as per NEP -2020 guidelines. After satisfactory completion of 40 credits of courses in two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Food Nutrition and Dietetics on exit. The students continuing the study further, would not have to attend the internship after 1st year.

- An institution (university or college) may work independently or in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running various skill enhancement courses. In such cases, while the parent institution will control admission process, develop the content, delivery module of the program and monitor the learning and skill development by students, the evaluation can be done jointly by the collaborating partners.
- The second year has been designed with the basic courses as well as fundamental courses in food science, human nutrition and normal dietetics with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications in the discipline. Students will be studying 4 credits of SEC in second year also. After satisfactory completion of the courses of 2nd year (total 80 credits for the two years) and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Food Nutrition and Dietetics on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- University/HEI may offer courses in any area as identified by it, based on institutional expertise/ capabilities/resources.
- Skill Enhancement Courses' (SEC) list as suggested by UGC. Any of these courses can be considered for inclusion under SEC category.
- The third-year courses have been designed to impart specialized knowledge to the students in the major disciplines i.e. Food Science, Nutrition science and Dietetics and Hospitality management. Students may opt courses from one or more options. The students, from other disciplines, who wish to take minor package from Food Nutrition and Dietetics may opt any one elective module given after Sem VIII, and take desired no of credits in consultation with faculty mentor who will ensure that basic courses are included in the package.
- There would not be exit option after third year as it is a professional course.
- During the 5th semester, the students will have a study tour/ industry visit of 10-12 days duration, which will be of 2 credits (Non-gradial).
- Students shall have elective courses in VII and VIII Semester for the award of degree i.e. B.Sc. Food Nutrition and Dietetics (Hons).
- In the fourth year of the course the focus is on strengthening of the knowledge and skill, and also on developing confidence of the students to take up either nutrition counselling, therapeutic counselling for patients, R&D project in industry or entrepreneurship, provision of internship,

in-plant training and project has been kept in addition to the basket of elective courses. The student will have the option to choose the internship or training module in consultation with a faculty mentor. In-plant training may be conducted in split manner in more than one industry/ organization/ institutions.

- There will be adequate choice of electives/ specialization for the students, in the 4th year. The Universities will have flexibility to include more courses as Electives depending on specific needs and expertise available. The objective is to enable the student to acquire deeper understanding in any particular field.
- In order to inculcate the moral and experiential habits in students, research methodology and ethics have been included besides Students Rural and Entrepreneurial Awareness Development Yojana (Student-READY program).
- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.
- The students will take 10 credits of online courses either from MOOC/Swayam/ NPTEL/ mooKIT/ edX/ Coursera or any other portal accepted by the University during the third and fourth year as a partial requirement for the B.Sc. Food Nutrition and Dietetics (Hons.).
- The online courses may relate with the main discipline or from any other discipline like social science, psychology, anthropology, economics, business management, agriculture, veterinary, language/humanity, music, etc. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.
- These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- After satisfactory completion of fourth year course requirements of 167 credits and online courses of 10 credits, the student will become eligible for the award of Degree in BSc. Food Nutrition and Dietetics (Hons).
- Online courses/MOOCS, SWAYAM, student will own planning and execution under intimation to the Dean/ authority.
- The social skills acquired by the students will also make the students more empathetic towards the society and social issues.

Entry and Exit Options

The entry and exit options for the UG programs in Food Nutrition and Dietetics are shown in the Fig.-1

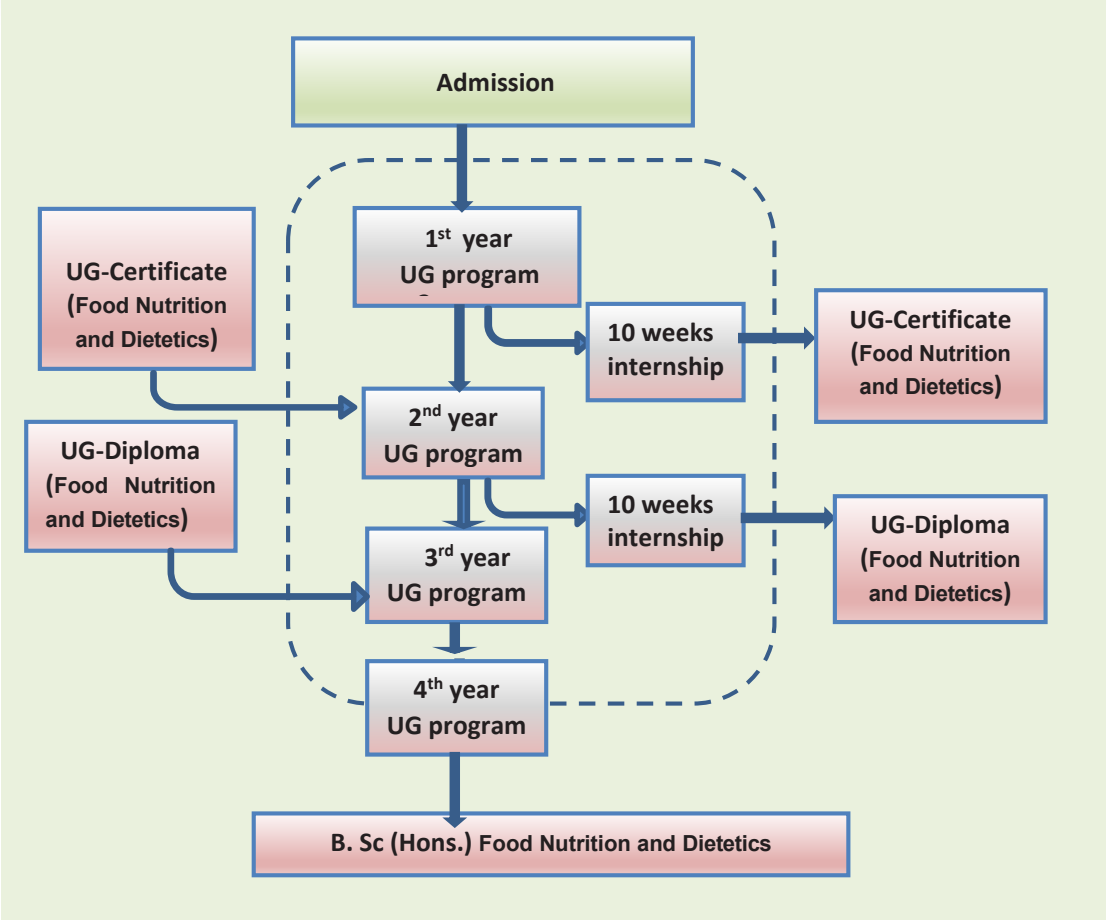

Fig.1 Entry and Exit options for the UG programs in Food Nutrition and Dietetics

Exit options

- **UG-Certificate in** Food Nutrition and Dietetics (Exit after first year and completion of 10 weeks' internship)
- **UG-Diploma in** Food Nutrition and Dietetics (Exit after second year and completion of 10 weeks' internship)
- **B.Sc. (Hons.)** Food Nutrition and Dietetics (On successful completion of four-year degree requirements)

  Admission Eligibility: +2 Science with Biology or Mathematics as one subject/Agriculture

ACADEMIC PROGRAM
Semester wise course distribution

Semester	Course Title	Credit Hours	Total Credits
First Year			
I semester			
1.	Deeksharambh (Induction cum Foundation Course)	2 (0+2) NG Non-gradial	**21 (8+13) + 2 (Non-gradial)**
2.	Fundamentals of Horticulture	3 (2+1)	
3.	Plant Propagation and Nursery Management of Fruit and Plantation crops	3 (1+2)	
4.	Commercial production of Flower crops	3 (1+2)	
5.	Farming Based Livelihood Systems	3 (2+1)	
6.	Sprinkler and Micro irrigation systems	2 (1+1)	
7.	Communication Skills	2 (1+1)	
8.	Skill Enhancement Courses (SEC-I)*	4 (0+4)	
9.	NCC-I/NSS-I	1 (0+1)	
II Semester			
1.	Introduction to Major Field crops	3 (2+1)	**22 (10+12)**
2.	Commercial Production of Spices and Plantation crops	3 (2+1)	
3.	Plant Propagation and Nursery Management in Vegetables, Flowers and Medicinal crops	3 (1+2)	
4.	Personality Development	2 (1+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Skill Enhancement Courses (SEC-II)*	4 (0+4)	
8.	NCC-II/NSS-II	1 (0+1)	
Post-II Semester			
1.	Internship (for 10 weeks-only for exit option for award of UG-Certificate)	10 (0+10)	
Second Year			
III Semester			
1.	Fundamentals of Soil Science	3 (2+1)	**20 (11+9)**
2.	Commercial Fruit Production	4 (3+1)	
3.	Precision Farming and Protected Cultivation	3 (2+1)	
4.	Seed Production of Vegetable, Tuber and Spice crops	3 (2+1)	
5.	Disease Management of Horticulture crops	3 (2+1)	
6.	Physical Education, First Aid,Yoga Practices and Meditation	2 (0+2)	
7.	Skill Enhancement Courses (SEC-III)*	2 (0+2)	

Semester	Course Title	Credit Hours	Total Credits
	IV Semester		
1.	Commercial Vegetable Production	4 (3+1)	**22 (13+9)**
2.	Farm Power and Machinery for Horticulture	3 (2+1)	
3.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
4.	Urban and Peri Urban Horticulture	2 (1+1)	
5.	Agriculture Marketing and Trade	3 (2+1)	
6.	Pest Management of Horticulture crops	3 (2+1)	
7.	Introductory Agrometeorology and Climate Change	2 (1+1)	
8.	Skill Enhancement Courses (SEC-IV)*	2 (0+2)	
	Post-IV semester		
1.	Internship (for 10 weeks-only for exit option for award of UG-Diploma)	10 (0+10)	
	Third Year		
	V Semester		
1.	Fundamentals of Plant Breeding	3 (2+1)	**20 (12+8) + 2 (Non gradial)**
2.	Growth and Development of Horticultural crops	3 (2+1)	
3.	Soil Fertility and Nutrient Management	3 (2+1)	
4.	General Microbiology	3 (2+1)	
5.	Information and Communication Technology in Horticulture	3 (1+2)	
6.	Introductory Crop Physiology	2 (1+1)	
7.	Basic Statistics and Experimental Designs	3 (2+1)	
8.	Education Tour	2 (0+2) Non-gradial	
	VI Semester		
1.	Introductory Agroforestry	3 (2+1)	**22 (13+9)**
2.	Laboratory Techniques for Horticultural crops	2 (0+2)	
3.	Principles of Biochemistry	3 (2+1)	
4.	Dryland Horticulture	3 (2+1)	
5.	Economics and Marketing	3 (2+1)	
6.	Principles and Practices of Natural Farming	2 (1+1)	
7.	Horticulture Based Integrated Farming System	3 (2+1)	
8.	Processing and Value Addition of Horticulture crops	3 (2+1)	
	Fourth Year		
	VII Semester		
1.	**Elective Courses**- Students will opt one of the elective discipline and accordingly the courses offered by University may be taken		**20**
	Fruit Science	20	
	Vegetable Science	20	
	Floriculture and Landscaping	20	

Semester	Course Title	Credit Hours	Total Credits
	VIII Semester		
1.	Student Ready (RAWE/ Industrial Attachment/ Project work/ Internship)	20 (0+20)	**20**
		TOTAL	**80 + 87 +4 #**
		Grand total	**167 +4 #**

* From the basket of Skill Enhancement Course (SEC) modules

Non gradial courses- *Deeksharambh* (0+2); Edu Tour (0+2)

Department/ section wise course breakup

Foundation course		
	Course Title	**Credits**
1.	*Deeksharambh* (2 weeks)	2 (0+2)

Skill Enhancement Courses (SEC)		**Credits**
1.	Mushroom Cultivation	2 (0+2)
2.	Apiculture	2 (0+2)
3.	Orchard Floor Management	2 (0+2)
4.	Landscape Gardening	2 (0+2)
5.	Packing and Packaging of Horticultural Crops	2 (0+2)
6.	Farm Machinery	2 (0+2)
7.	Introduction to Forestry	2 (0+2)
8.	Installation, Operation and Maintenance of Micro-irrigation System	2 (0+2)
9.	Computer Programming and Data Structures	2 (0+2)
10.	Turf and Turf Management	2 (0+2)
11.	Post-Harvest Management of Horticultural Produce	2 (0+2)
12.	Nursery Production in Horticulture crops	2 (0+2)
13.	Seed Production techniques in Vegetable crops	2 (0+2)
14.	Sericulture	2 (0+2)

Note: The University/ Institute may offer more Skill Enhancement courses relevant to the region and the subject.

Core (Major/ Minor Course)

Fundamentals of Horticulture	3 (2+1)
Plant Propagation and Nursery Management of Fruit and Plantation crops	3 (1+2)
Plant Propagation and Nursery Management in Flowers and Medicinal and crops	3 (1+2)
Growth and Development of Horticulture crops	3 (2+1)
Commercial Fruit Production	4 (3+1)
Commercial Vegetable Production	4 (3+1)

Commercial Production of Flower crops	3 (1+2)
Dry land Horticulture	3 (2+1)
Urban and Peri Urban Horticulture	2(1+1)
Sprinkler and Micro Irrigation systems	2 (1+1)
Laboratory Techniques for Horticulture crops	2 (0+2)
Processing and Value Addition of Horticulture crops	3 (2+1)
Farm Power and Machinery for Horticulture	3 (2+1)
Pest management of Horticulture crops	3 (2+1)
Disease Management of Horticulture crops	3 (2+1)
Information and Communication Technology in Horticulture	3 (1+2)
Commercial production of spices and plantation crops	3 (2+1)
Precision farming and protected cultivation	3 (2+1)
Horticulture based integrated farming system	3 (2+1)
Seed production of vegetables, tuber and spice crops	3 (1+2)
Soil Fertility and Nutrient Management	3 (2+1)
Fundamentals of Soil Science	3 (2+1)
Introduction to Major Field crops	3 (2+1)
Fundamentals of Plant Breeding	3 (2+1)
Introductory Agroforestry	3 (2+1)
Introductory Agrometeorology and Climate Change	2 (1+1)
Economics and Marketing	3 (2+1)
Introductory Crop Physiology	2 (1+1)
Principles of Biochemistry	3 (2+1)
General Microbiology	3 (2+1)
Basic Statistics and Experimental Designs	3 (2+1)
Principles and Practices of Natural Farming	2 (1+1)

Elective courses

Fruit Science	
Production Technology of Tropical Fruit crops	3 (2+1)
Production Technology of Sub tropical and temperate Fruit crops	3 (2+1)
Breeding of Fruit crops	3 (2+1)
Canopy Management in Fruit crops	3 (2+1)
Biotechnological Approaches and Micropropagation in Fruit crops	3 (2+1)
Production Technology of Arid Fruit crops	3 (2+1)
Postharvest Management for Fruit crops	2 (1+1)

Vegetable Science	3 (2+1)
Production Technology of Warm Season Vegetable crops	3 (2+1)
Production Technology of Cool Season Vegetable crops	3 (2+1)
Production Technology of Tuber crops	3 (2+1)
Breeding of Vegetable crops	3 (2+1)
Biotechnological approaches and Micropropagation in Vegetable crops	3 (2+1)
Postharvest Management of Vegetable crops	3 (2+1)
Protected cultivation of Vegetable crops	2 (1+1)
Floriculture and Landscaping	
Turf Management	2 (1+1)
Protected Cultivation of Flower crops	3 (2+1)
Value Addition in Floriculture	3 (2+1)
Breeding of Ornamental crops	3 (2+1)
Principles of Landscape Architecture	3 (2+1)
Commercial Floriculture and Landscaping	3 (2+1)
Postharvest handling of Floriculture crops	3 (2+1)

Note: The University/ Institute may offer more electives/courses relevant to the subject.

Multidisciplinary Courses (MDC)

Farming Based Livelihood Systems	3 (2+1)
Entrepreneurship Development and Business Management	3 (2+1)
Agriculture Marketing and Trade	3 (2+1)

Value Added Courses (VAC)

Environmental Studies and Disaster Management	3 (2+1)
Agriculture Informatics	3 (2+1)

Ability Enhancement Courses (AEC)

Communication Skills	2 (1+1)
Personality Development	2 (1+1)
Physical Education, First Aid and Yoga	2 (0+2)
NCC/NSS	2 (0+2)

SUMMARY OF CREDIT DISTRIBUTION

Type of courses	Credits
Core courses (major and minor/s)	112
Common courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Internship / Student READY	20
Non-Gradial Courses [*Deeksharambh* and Educational Tour]	4*
Online Courses / MOOCs	10**
Total	167 + 10**

*Non-Gradial ** Online courses

Table 1. Credits Allocation Scheme of UG Food Nutrition and Dietetics program (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	11	3[2]		1[3] + 2[4]	1	-	21	2[1]		
II	9	3[5]	3[6]	1[3] + 2[4]	4	-	22	-	10[12]	
III	16	--		2[8]	2	-	20	-		
IV	14	3[9]	3[10]	----	2	-	22	-	10[13]	**10**
V	20	-	-	-	-	-	20	2[11]		
VI	22	-	-	-	-	-	22	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2weeks duration)
[2] Farming based Livelihood systems
[3] NCC/NSS
[4] Communication Skills
[5] Entrepreneurship Development and Business Management
[6] Environmental Studies and Disaster Management
[7] Personality Development
[8] Physical Education, First Aid and Yoga Practices
[9] Agriculture Marketing and Trade
[10] Agriculture Informatics
[11] Study tour (10-14 days)
[12] Only for those opting for an exit with UG-Certificate
[13] Only for those opting for an exit with UG-Diploma

DETAILED SYLLABI

Semester I

Deeksharambh (Induction-cum-Foundation program) 0+2 (NG)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Introduction to Food Science and Nutrition 3(3+0)

Objectives

1. To make student understand basic nutrients, their functions, requirements and availability in different food groups
2. Understanding of the changes that occur in foods during preparation, processing and preservation.
3. Understanding the nutritive value of different foods and methods of preserving them during cooking.

Theory

Introduction and overview of basic principles of nutrition. Relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition - recommended dietary allowances, balanced diet, health, functional foods, phytochemicals, nutraceuticals, dietary supplements, food groups. Concepts of food science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.). Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavors, colors, miscellaneous bioactive compounds, important reactions). Food microbiology (bacteria, yeast, molds, spoilage of fresh and processed foods, production of fermented foods). Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.). Food and nutrition, malnutrition (over and under nutrition), nutritional disorders. Energy metabolism (carbohydrate, fat, proteins). Balanced/ modified diets. Menu planning. New trends in food science and nutrition. Food Groups.

Suggested Readings

1. Khader V (2003) Food, Nutrition and Health. Kalyani Publishers, Ludhiana.
2. Sehgal S and Raghuvanshi RS (2007) Textbook of Community Nutrition. DIPA, Indian Council of Agricultural Research, New Delhi.
3. Gopalan C, Rama Sastri B V and Balasubramanian S C (2011) Nutritive value of Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.
4. Gurtherie H A (1989) Introductory Nutrition. Times Mirror, St. Louis.
5. Joshi S A (1999) Nutrition and Dietetics. Tata McGraw Hill Publishing Co Ltd, New Delhi.
6. Roday Sunetra (2010) Food Science and Nutrition. Oxford University Press, New Delhi.
7. Srilakshmi B (2005) Food Science. New Age International (P) Ltd., Publishers, New Delhi.

8. Potter N (2005) Food Science, CBS Publishers and Distributors, Delhi.
9. Srilakshmi B (2015) Nutrition Science. New Age International Pvt. Ltd. New Delhi.

Principles and Practices of Food Preparation 2 (1+1)

Objectives

The student will be able to:

1. Understand effect of heat transfer on texture, flavour, taste and appearance of food
2. Demonstrate correct use of small equipment and appliances
3. Identify and apply scientific principles of food selection and preparation, prepare and handle food using safe, sanitary practices; in order to retain Nutritive value and produce quality food products
4. Demonstrate and understand ingredient substitution for recipe and describe characteristic properties of quality food products

Theory

Kitchen attire and equipment, cooking of food, heat and heat transfer cooking methods, effect of cooking on food and their nutritive value, basics of culinary practice, thickening and binding agents, basic flavoring stocks essence and glazes sauces soups garnishes, basics of cookery of various food - cereals, pulses, egg, fish, meat and poultry, principles and practice of boiling, steaming, frying, stewing, roasting, baking, grilling and combined methods of cookery

Practical

Kitchen Equipment - Identification, Description, Uses and handling. Market survey to assess the types and availability of processed products. Identification and Selection of Ingredients. Preparation of cereal products and pulse products- boiling and steaming, puffing. roasting methods. Basic dry heat cooking methods. Basic medium fat cooking – Roasting, grilling, frying. Milk cookery – pudding, custard and ice creams. Preparation of Vegetable- Boiled vegetables and Glazed vegetables. Preparation of Vegetable- Fried vegetables and Stewed vegetables. Egg cookery - Boiled (Soft and Hard), Fried, Poaches, Scrambled, Omelets. Preparation of Simple Salads: Potato salad, Beet root salad, green salad, Fruit salad, Preparation of baked products. Cold desserts - Caramel Custard, Bread and Butter Pudding, Soufflé – Lemon / Pineapple, Mousse (Chocolate Coffee Apricot Pudding HOT desserts - Steamed Pudding. Preparation of meat and products. Preparation of Continental Stock: White stock, brown stock, chicken stock and emergency stock. Preparation of confectionery products - fudge, fondant, candies, toffees and chocolates, Identification of meat cuts of lamb, Curing of meat – sugar, salt and nitrite, Cost reporting system – daily, monthly and for special managerial decisions. Visit to kitchen equipment stores

Suggested Readings

1. Brown, A. (2018). Understanding Food: Principles and Preparation. Wadsworth Publishing Co Inc.
2. Chambers, M. D. (2009). Principles of food preparation; a manual for students of home economics. Boston cooking-school magazine Company, 1914.

3. Sethi, M. (2007). Catering Management – An Integrated Approach. New Age International (P) Limited Publishers, New Delhi.
4. The BC Cook Articulation Committee (2015). Basic Kitchen and Food Service Management. BC campus, British Columbia.

Indian Cuisinology 2 (0+2)

Objectives

1. To impart a hands-on, skill oriented intense curriculum on Indian Cuisine and Culture
2. To examine the central place of cuisine in Indian culture and society
3. To understand the importance of cuisine in cultural practices

Practical

Exploring Indian regional cuisines - North India, North East, South India, Western and Eastern India. Familiarization and identification of Indian herbs and spices. Preparation of dry/wet masalas, pastes and curries/gravies. Preparation of common recipes and meals of North, South, East, West and central zones of the country. Preparation of Mughlai cuisines. Preparation of food according to festivals in India. Preparation of non-alcoholic Indian beverages. Use of modern crockery/cutlery for presentation. Special meals during fasting. Street foods of India – Exploration and preparation.

Suggested Readings

1. Achaya K T (1998) Indian Food: A Historical Companion. Oxford University Press, USA.
2. Pant P (2007) Cuisines – Incredible India. Wisdom Tree, India.
3. O'Brien C (2012) Food Guide to India. Penguin India.
4. Martl Richard E and Derek Eelsy A (1998) Text book of basic cookery, Fundamental recipes and variations.
5. Mehta N (2013) Cookbook of Regional Cuisines of India. Snab Publishers, India.
6. Shukla S (2022) Plant-Based India: Nourishing Recipes Rooted in Tradition. The Experiment.
7. https://www.unigoa.ac.in/uploads/syllabus/bsc-culinary-arts_syllabus_33020210830.055146.pdf
8. https://www.uou.ac.in/sites/default/files/syllabus/BHM-401T.pdf.

Nutritional Status Assessment 3 (2+1)

Objectives

1. To cover the basic concepts of malnutrition, describes how nutritional status is assessed, and identifies the most commonly used nutrition indicators
2. To explain the criteria to consider when selecting the indicators in specific contexts and situations

Theory

Major Nutritional Problems–Global and India. Nutritional Status assessment – Direct and Indirect method, Anthropometric and Body composition methodology (indexes and references),

Biochemical Methods of Nutritional Assessment, Clinical nutrition methodology, Dietary Assessment methods. Nutrition Intervention programs and policies, Sustainable Nutrition Goals, Mental Health and well-being. Rapid assessment methods. Nutritional assessment of infants, -children, adults, elderly, pregnant and lactating women

Practical

Assessment of nutritional status of community using dietary surveys, clinical, surveys, anthropometric Measurements-Data collection, tabulation, data analysis (indexes and references), interpretation and report writing. Target group selection from pediatrics, adults, elderly, pregnant and lactating women, tabulation, interpretation and report writing of their tested biomarkers.

Suggested Readings

1. Sehgal S and Raghuvanshi RS (2007). Textbook of community nutrition. DIPA, Indian Council of Agricultural Research, New Delhi.
2. Latham M C (1997). Human nutrition in the developing world. Food and Agricultural Organization of United Nations.
3. Dahiya S, Boora P and Rani V (2013). A manual on Community Nutrition, Department of Foods and Nutrition, published under ICAR Assistance scheme.
4. Bamji S M, Rao N P and Reddy V (1996). Textbook of human nutrition. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
5. Flamino Fidanza (1991). Nutritional Status Assessment, Springer Science Business Media.
6. Beghan I, Cap M and Dajardan B (1988). A guide to Nutritional Status Assessment WHO Geneva.
7. Raghuvanshi R S and Mittal M (2014). Food Nutrition and Diet Therapy. India: Westville Publishing House New Delhi.

Convenience and Health Food Formulation 2 (0+2)

Objectives

1. Imparting understanding of convenience foods among students
2. Nutritional and health benefits of various healthy food recipes and convenience foods

Practical

Importance and need for convenience foods. Usefulness and types of convenience foods. FSSAI standards on health food formulations. Health foods-definition, classification and types. Food safety and quality control issues in product development. Packaging of convenience foods. Needs for effective marketing of convenience and health foods. Market survey of convenience and health foods. Cereal based traditional convenience foods and snacks. Convenience foods of millets. Ready to eat breakfast cereals. Pasta products. Legume/pulse based traditional convenience foods and snacks. Extruded products. Milk based products and mixes. Vegetable and fruit-based convenience foods. Food adjuncts (Pickles, chutneys, papad/vadi etc. Soup mixes. Fried products.

Suggested Readings

1. Arya S S (1990) Grain based snack and convenience foods. Indian Food Packer, Sept –Oct, page: 17- 34
2. Chattopadhyay P K (2007) Cereal Food Technology. Published by National Institute of Industrial Research. Pg 137-139.
3. Chaughan G S, Verma N S and Bains G S (1985) Effect of extrusion processing on the nutritional quality of protein in rice – legume blends. Die Nahrung.
4. Fast R B and Caldwell E F (2000) Breakfast Cereals and How they are made. American Association of Cereal Chemists., St. Paul, Minnesota.
5. Guy R. Extrusion Cooking, Technologies and Applications. Wood head Publishing Limited, Abington, and Cambridge.
6. Khatkar B S (2007) Food Science and Technology. Daya Publishing House, Delhi.
7. Pant P (2006) Indian Fast Food. Roli Books Pvt Limited.
8. Selves J and Devipriya J (2010) Health foods as Soya bean. Beverages and Food World Feb Pg-64.
9. Shiby V K, Sinija V R and Mishra H N (2007) Ready to eat health foods: A promising concept. Indian food Industry. Nov-Dec.pg.47-53.
10. Shukla S (2022) Plant-Based India: Nourishing Recipes Rooted in Tradition. The Experiment.

Farming based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood- Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start- Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C.and Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar]
3. Carloni, A. (2001). Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J., Gulliver, A. with Gibbon, D. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA
5. Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy.
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. (2020). Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. (2016). Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. (2015). Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and U. S. Walia. (2020). Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
11. Indian Dietetic Association. (n.d.). Retrieved from https://idaindia.com/.
12. National Institute of Nutrition. (n.d.). Retrieved from https://www.nin.res.in/.

Skill Enhancement Courses (SEC-I and SEC-II)

Objective

To enable the students to acquire basic skills in Food, Nutrition and Dietetics so that in case they exit with UG-certificate, they can be properly engaged or they can start their own enterprise. These are taken from the basket of available SEC modules as given in chapter-

Communication Skills 2(1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

National Cadet Corps (NCC- I) 1(0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning
- Sizing, numbering, forming in three ranks, open and close order march, and dressing
- Saluting at the halt, getting on parade, dismissing, and falling out
- Marching, length of pace, and time of marching in quick/slow time and halt Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control

National service scheme (NSS-I) 1 (0+1)

Objectives

1. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work
2. To be skillful in executing democratic leadership, developing skill in program
3. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health

- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

Semester II

Bakery Science and Technology 3 (2+1)

Objectives

1. To understand the process of different products, how their ingredients play a role in preparation of breads, cakes, biscuits, etc., their quality testing and how to modify products with desirable nutritional requirements
2. To provide individuals with key knowledge of packaging, labeling, food safety and food laws that can be applied directly in existing products and also in development of new products of bakery

Theory

Introduction to baking science. Basic materials used in bakery and confectionery, selection, properties and functions. Flours- constituents, functions and characteristics of good flour and tests. Different types of flour mixtures used bakery, egg structure, composition and its functions in bakery. Different types of fats and oils used in bakery and their functions. Sugars and functions and types of sugars used in bakery and confectionery, Salt and its functions in bakery and their functions, Yeast and types of yeast used in bakery and their functions. Improvers, leavening agents and emulsifiers used in bakery and their functions. Tools, equipment and techniques used in bakery.

Practical

Bakery unit: importance of sanitation and personal hygiene. Use of different bakery equipment microwave baking, balancing the formula for bakery products , demonstration on standard method of making different types of biscuits, salt, coconut and fruit biscuits Demonstration on standard method of making different types of cookies, preparation of different types of cookies, plain sponge cake, chocolate cake, pineapple upside down cake, walnut cake, madeira cake, fruit / plum cake, carrot cake, Demonstration on standard method of making of pastries, pastries, icings and cake decoration.

Suggested Readings

1. Ashok Kumar Y. 2012. Textbook of Bakery and Confectionery. PHI Learning, India.
2. Bakers Handbook on Practical Baking. 1994. US Wheat Associates, New Delhi
3. Mathuravalli S M D. 2022. Handbook of bakery and Confectionary. CRC Press.
4. NIIR Board of consultants and Engineers. 2014. The complete technology book on bakery products (Baking Science with formulation and production). NIIR Project consultancy services, New Delhi.
5. Scott D. 2020. Bread Baking for Beginners: A Simple essential guide to kneading and baking bread.

Nutritional program Surveillance 3 (1+2)

Objectives

This course will enable the students to-

1. Understand the concept of nutritional status and its relationship to health
2. Know aims, objectives, methods used for assessment of nutritional status
3. Identify the factors responsible for the malnutrition

Theory

Nutrition monitoring and surveillance – definition, introduction, need and significance. Principles of a food and nutrition surveillance system and implementation steps. Nutrition surveillance in developed and underdeveloped countries. Setting up food and nutrition surveillance system activities -strengthening a food and nutrition surveillance system. Nutritional programs – implementation, monitoring and evaluation. Concept of E-surveillance on the Nutritional situation in the country. Elements of the nutritional assessment - individual and population assessment - measuring malnutrition. Sampling of population. Supervision, monitoring and evaluation. Real time monitoring system. Malnutrition – causative factors. Food security assessment, health assessment and its significance in nutrition surveillance. Indicators of food and nutrition security – types and characteristics of indicators. Application and usefulness of indicators for different objectives and nutritional problems. Selection of indicators and levels of assessment.

Practical

Surveillance of National nutrition programs: ICDS, mid-day meal, availability of iodized salt in markets and households, distribution of iron-folifer tablets. Visit to ICDS centers, PHCs, *Aaganwadis*, assessing nutritional status, data analysis and report writing, visit to mid-day meal kitchen, supervising food preparation in hygienic manner, report writing.

Suggested Readings

1. Bamji M S, Rao Prahlad N and Reddy Vinodini. 2003. Text book of Human Nutrition (p-p 197-201). New Delhi. Oxford and IBH Publishing Co. Pvt. Ltd.
2. Beghan I M and Dajardan B. 1988. A guide to Nutritional Status Assessment WHO Geneva.
3. Derrick B Jelliffe. 1966. The assessment of the nutritional status of the community (With special reference to field surveys in developing regions of the World). World Health Organization, Geneva.

4. Flamino Fidanza.1991. Nutritional Status Assessment, Springer Science Business Media.

5. Gopaldas T and Seshadri S. 1987. Nutrition monitoring and assessment, Oxford University press.

6. Mason J B, Habicht J P, Tabatabai H and Valverde V. 1984. Nutritional Surveillance. WHO

7. Sehgal S and Raghuvanshi RS. 2007. Textbook of community nutrition. DIPA, Indian Council of Agricultural Research, New Delhi.

8. Saln D R, Lockwood R and Scrimshaw N S. 1981. Methods for the evaluation of the Impact and Nutrition program, U N University.

9. Spinello S. 2018. The duties of a community nutritionist. Cited from: https://careertrend.com/list- 6526713-duties-community-nutritionist.html

10. WHO 2014. Food and nutrition surveillance systems. A manual for policy-makers and program manager.

Food Preservation and Storage 2 (0+2)

Objectives

1. To provide information about the shelf-life of different food products, different preservations and processing techniques
2. To provide Students hands on experience and knowledge about handling of food items on scientific lines to prepare and develop different preserved food product

Practical

Market survey of raw and preserved products. Preparation of preserved products- Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, *murabbas*, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Drying of blanched and unblanched fruits and vegetables by solar dryer, sun and oven drying methods. Shelf life and sensory evaluation of developed products Packaging of fruits and vegetables. Labelling and costing of products. Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Preparation of *papad, wadian* utilizing cereals and legumes and their storage. Visits to food processing and preservation units, canning bottling units, grain storage institute.

Suggested Readings

- Bhutani, R. C. 2011. Fruit and Vegetable Preservation. Daya Publishing House.
- Jood, S. and Khetarpaul, N. 2002. Food Preservation. Geeta Somani, Agrotech Publishing Academy, Udaipur.
- Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Potter, N.N. 1996. Food Science. The AVI Publishing Company, Inc. Westport, Connecticut.
- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. 1997. Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Sivasankar, B. 2002. Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi
- Srivastava, R. P. and Kumar, S. 2019. Fruits and Vegetable Preservation: Principles and

Practices. Revised and Enlarged 3rd edn. CBS publishers and distributors.

- Subbulakshmi, G. and Udipi, S.A. 2006. Food processing and preservation. New Age International Publishers.
- Vijay K., 1999. Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.

Personality Development **2 (1+1)**

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types . The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, FIRO-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
6. Mile, D.J., 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
7. Shaffer, D. R., 2009, Social and Personality Development (6th edn). Belmont, CA: Wadswor.
8. Smith, B., 2004, Body Language. Delhi: Rohan Book Company.

Entrepreneurship Development and Business Management **3 (2+1)**

Objectives

1. To provide an insight into the concept and scope of entrepreneurship

2. To expose various aspects of establishment and management of a small business unit
3. To develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity- scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
4. Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
8. Mehra P., 2016. Business Communication for Managers. Pearson India, New Delhi.
7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
9. Singhal RK. 2013. Entrepreneurship Development and Management, Katson Books.
10. Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

1. To expose and acquire knowledge on the environment
2. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth

- Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. € Noise pollution. (f) Thermal pollution.

(g) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment:

Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural

to study common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. Bharucha, Erach. Text book for Environmental studies. University Grants Commission, New Delhi.
2. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
3. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
4. Parthiban, K.T., Vennila, S., Prasanthrajan, M. and Umesh Kanna, S. 2023. (In Press). Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. 1st edn.
6. Prasanthrajan, M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment. Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

National Cadet Corps-II 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice- versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme-II 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post- Semester II (Only for exit option for UG-Certificate)

S. No.	Course Title	Credit Hours
1.	Internship*(10 weeks)	**10 (0+10)***

*Internship (only for exit option for award of UG-Certificate) 10 weeks 10 (0+10)

Objectives

To provide students with an opportunity to put into practice the skills they have learned while in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and consider having their own startups.

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills in the job interview process
5. Explore career alternatives prior to graduation

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in associated industry, food service centres, etc. The College/ University will facilitate attaching the students to the organisations. After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Principles of Human Nutrition 4 (4+0)

Objectives

At the end of the course, the student will have knowledge of

- Different types of carbohydrates, lipids and fatty acids and proteins and amino acids required for human nutrition
- Energy requirement and expenditure in the human body during rest and physical activity
- Physiological and biochemical role of water, minerals and vitamins and their metabolism in the human body
- Diseases and symptoms resulting from deficiency of major and minor nutrients
- Biochemical monitors used to assess the nutritional status of different nutrients

Theory

Historical development and the relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition- Recommended dietary allowances, balanced diet, health foods, functional foods, phytochemicals, Nutraceuticals, dietary supplements, ethnic foods, organic foods, fabricated foods, extruded foods, convenience foods, junk foods, GM foods and proprietary foods. Food groups (Four, Five, Seven, Nine, Eleven), Food pyramid, my plate concept, Bioavailability, enrichment, fortification and restoration of nutrients. Energy units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food, Respiratory Quotient, SDA, BMR- methods of measurement, factors affecting BMR, Energy expenditure in different activities, Energy balance. Carbohydrates- Types, functions, sources, requirement, Digestion and absorption of carbohydrates, health conditions affected by carbohydrates, Dietary Fiber-Classification, sources, composition,

properties and nutritional significance. Lipids- Types, functions, sources, requirement, Digestion and absorption of lipids health problems associated with lipids. Proteins- Types, functions, sources, requirement, Digestion and absorption of proteins, quality evaluation, improvement and deficiency and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of fat soluble-(A, D, E, K), (water soluble – C, B Complex (thiamine, riboflavin, niacin, B_6, Pantothenic acid, B_{12} and folic acid). Minerals-Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc, factors affecting bio availability of calcium and iron and other minerals. Water- functions, sources, distribution in body. Water balance and electrolyte balance.

Suggested Readings

- Agrawal, A. and Udipi, A.S. 2022. Textbook of Human Nutrition. Jaypee Brothers Medical Publishers.
- Recommended dietary allowances and estimated average requirements nutrient requirements for Indians – 2020- A Report of the Expert Group Indian Council of Medical Research, National Institute of Nutrition
- Raghuvanshi, R. S. and Mittal, M. 2014. Food Nutrition and Diet Therapy. India: Westville Publishing House New Delhi
- Bamji, M.S., Krishnaswamy, K. and Brahmam, G.N.V. 2009. Text book of Human Nutrition. Oxford and IBH Publishing Company Pvt. Ltd.
- Sehgal, S. and Raghuvanshi, R.S. 2007. Text Book of Community Nutrition. ICAR Publication.
- Wilson, E.D., Fisher, K.H. and Garcia, P.A. 1980. Principles of Nutrition. John Wiley and Sons, New York.
- Longvah, T., Ananthan, R., Bhaskarachary, K. and Venkaiah, K. 2017. Indian Food Composition Tables. National Institute of Nutrition, ICMR, New Delhi.

Fundamentals of Food Science 2 (1+1)

Objectives

1. To introduce students to the field of food science
2. To cover possible jobs, food harvest, production methods, food chemistry, preserving methods, meeting nutritional needs, grading procedures used and the science involved
3. To understand both fundamental and applied aspects of food science
4. To provide for fundamental understanding of food chemistry, and food microbiology
5. To gain insights about role of specific nutrients in maintaining health and identifying nutrient specific foods

Theory

Cooking- Objectives, cooking methods, their types, merits and demerits. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery, gelatinization, dextrinization, antinutritional and retrogradation of starch. Legumes, nuts and oil seeds - Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Milk and

milk products – Composition, types, products, effect of acid on pigments, effect of acid on milk cookery, uses and functions. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish- Types, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Sugars- Types, composition, manufacturing process, effect of heat and acid, crystallization factors affecting crystallization, functions of sugar in cookery, fondants and fudge. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats; Methods of improving nutritive value of foods – germination, fermentation, malting, mutual supplementation etc. Brief overview of beverages; Condiments and spices, importance in daily life.

Practical

Orientation to kitchen equipment and their uses, weighing and measuring food items. condiments and spices. Cooking of foods using different methods. Cereal cookery– Practical exercise on dextrinization and gelatinization of rice starch, gluten formation in wheat. Legumes – Identification and cooking methods. Nuts and oilseeds- Use in food preparations. Preparations using Germination, fermentation, mutual supplementation. Vegetable cookery- Different preparations with vegetables and effect of heat and alkali on pigments. Preparation of soups, salads and beverages. Milk and milk products- Maillard reaction, Use in various preparations. Egg cookery - Preparations showing functions of egg as binding, coating agent: poached egg, boiled egg, scrambled egg, omelet, egg curry. Meat, poultry and fish cookery – Preparations involving various methods of cooking. Sugar – Preparations showing functions of sugar in cooker- caramelization, coating agent, crystallization, syrups of different consistencies, sweets, chocolates, candies. Fats and oils – Demonstration of smoking point, use in various preparations like deep fat frying, shallow fat frying, shortening effects of oil, factors affecting absorption of oil.

Suggested Readings

1. Sharma, A. 2017. Textbook of Food Science and Technology. CBS Publication.
2. Fox, B. F. and Cameron, A. G. 1970. Food Science - a Chemical Approach. University Press, London.
3. Raghuvanshi, R.S. and Bisht, K. 2010. Uses of Soybean: Products and Preparation.
4. Raghuvanshi, R.S. and Singh, D.P. 2009. Food preparations and use.
5. Shakuntala Manay N, Shadaksharaswamy M. 1998. Foods, Facts and Principles, New Age International Publishers, New Delhi.
6. Singh, Guriqbal (Ed.). Soybean: Botany, Production and Uses, CAB International, U.K.
7. Swaminathan, M. 1988. Handbook of Food Science and Experimental Foods BAPPCO, Bangalore.
8. William Erskina *et al.* (Eds). The Lentil: Botany Production and Uses. CAB International, U.K.

Community Nutrition and Education 3 (2+1)

Objectives

At the end of the course, the student will have knowledge of

1. Causes, prevalence and consequences of the major nutritional problems existing in India and its control measures
2. Methods of nutritional status assessment of individual and group both directly and indirectly

3. To inculcate concept of food and nutrition security and government and international program running in the field of community nutrition for ameliorating nutritional status of population
4. To enable students to assess nutritional status and impart nutrition education among rural and needy people

Theory

Basic concept of community nutrition role of nutritionist in improving nutrition in community Food habits and influencing factors, Food taboos, Mortality and morbidity pattern of vulnerable groups and their causes. Nutritional needs of normal infants, prelacteal feeding, exclusive breast feeding, feeding of full term and premature infants. Importance of breast feeding and supplementary foods in combating malnutrition in infants and young children. Growth monitoring Malnutrition. Definition and causes, classification of grades of malnutrition. Assessment of nutritional status-Nutritional Anthropometry-Need and importance, standard for reference, techniques of measuring Length/ height, weight, head, chest and arm circumference, skinfold thickness, interpretation of these measurements. Use of growth chart, Clinical signs of deficiencies specially PEM (Kwashiorkor, marasmus), vitamin A deficiency, Anemia, Rickets, B-Complex deficiencies. Bio chemical and biophysical assessment. Diet survey: Need and importance, methods of dietary survey, Interpretation - concept of consumption unit, individual and total distribution of food in family, adequacy of diet in respect to RDA, concept of family food security. Major nutritional problems in community. National programs and policies for improving nutritional status of community. Role of national and international agencies in improving nutritional status of the community. Nutrition education: objectives, methods, channels and its role in control of malnutrition in community nutrition education -Objectives, principles and importance of nutrition education in a community nutritional survey – NFHS.

Practical

Assessing nutritional status of hostel inmates and local community dwellers. Assessing nutritional status of community as per socio-economic status. Visit to local health centres to identify clinical signs and symptoms of nutritional problems. Visit to Anganwadi centres, MDM and evaluation of feeding provided at these centres. Community survey for nutritional deficiency disorders -Data collection, tabulation, analysis, interpretation report writing. Development of audio- visual aids. Planning, implementation and evaluation of nutrition education program for a target group.

Suggested Readings

1. Bamji, S.M., Rao, N.P. and Reddy, V. 1996. Textbook of human nutrition. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
2. Dahiya, S., Boora, P. and Rani, V. 2013. A manual on Community nutrition, Dept. of Foods and Nutrition, published under ICAR, Assistance scheme.
3. Das, S. 2022. Textbook of Community Nutrition. Academic Publishers.
4. Latham, M.C. 1997. Human nutrition in the developing world. Food and agricultural organization of United Nations.
5. Sehgal, S. and Raghuvanshi, R.S. 2007. Textbook of community nutrition, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.

Human Physiology 3 (2+1)

Objectives

1. To understand the role of molecules, cells, tissues, organs, and organ systems (endocrine, nervous, muscular and immune systems) in human health and disease
2. To understand the physiology –the functioning of a living organism and its component parts
3. To acquire an understanding of how and why the body functions the way it does, and what happens when it does not function properly

Theory

Introduction to anatomy and physiology and structural organization of body. The cell – Structure, its organelles, functions and multiplications, different types of cells and their functions, movement of particles across cell membrane - Active transport and passive transport ,Body fluids and its compartments and functions ,Water output and input into the body and maintenance of water balance in human body , the tissues – Types, structure and their functions, the skeletal system - Anatomy and functions, structure, formation and development of bones, different types of bones and types of joints and their movements, Circulatory system - The blood - Composition and function, blood clotting and blood grouping, Heart – Structure, functions, types of circulatory systems, blood pressure and heart rate and factors affecting it, electrocardiogram, the respiratory system - anatomy, functions, mechanism of breathing and respiratory volumes, gas transport and respiratory adaptation, the digestive system - anatomy and functions of alimentary tract and accessory organs, process of digestion of food, absorption and assimilation of digested food, enzymes involved in digestion of food, liver - Structure and functions, Pancreas – Structure and functions, the urinary system - Anatomy and functions, formation and composition of urine, the endocrine system - important ductless glands of the body and their functions, the reproductive system - Male reproductive system – Anatomy and functions, female reproductive system – Anatomy and functions, menstrual cycle, the nervous system - elementary study of (anatomy and functions), sensory organs – (anatomy and functions). Glossary of terms used in physiology.

Practical

Study of a compound microscope, microscopic structure of epithelial, muscular and connective tissue, bone and cartilage, Measurement of body temperature, Basal Metabolic Rate, Recording of systemic arterial blood pressure, Pulmonary function test, Pulse rate and respiratory rate, Effect of posture and exercise on blood pressure. Visit to anatomy and physiology lab, estimation of hemoglobin, red blood corpuscles, estimation of white blood corpuscles, determination of blood groups assessment of blood group, determination of bleeding time (bt) and clotting time (ct). Determination of blood glucose qualitative tests with urine samples -urine sugar and albumin.

Suggested Readings

1. Arthur J. V. Human physiology- The mechanisms of body function. Tata McGraw Hill Publishing Company, New Delhi.
2. Guyton C. Text Book of medical physiology. 5th edn. W.B. Saunders Company- Philadelphia, London
3. Samson's Applied Physiology. 10th edn. Revised by Keele, C.A. and Neil, B. Oxford University Press, New York.

Economics and Food Business Management 2 (2+0)

Objectives

1. To study food from a scientific perspective and the food industry from a business point of view
2. To have opportunities to create new food products and develop new ways to manufacture, preserve, and package food products
3. To study food production, development, and commercialization

Theory

Economics definition and key concepts; business economics. The working of competitive markets: business in a competitive market; demand and supply population and growth food production availability, price and output determination; elasticity of demand and supply; Government intervention in competitive markets (FCI, Food Subsidies). Background to demand: marginal utility theory and demand and the firm. Background to supply: cost and production; short vs long-run. Revenue and profit maximization. Market Structures: Perfect competition, monopoly, monopolistic competition. Business in an international environment: globalization (key concepts). Business Management- Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line and staff, matrix, hybrid.

Suggested Readings

1. Dewett, K.K. and Navalur, M.H. Modern Economic Theory. S. Chand and Sons, New Delhi.
2. Dorfman, Jeffrey H. 2013. Economics and Management of the Food Industry. Taylor and Francis
3. Jain, S.P. Financial Accounting. Kalyani Publications, Ludhiana.
4. Koontz, Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
5. Prasad, L.M. 2001. Principles and Practices of Management, 9th edn. S. Chand and Sons, New Delhi.
6. Rao, P. Subba. Human Resource Management. Himalaya Publications.
7. Thomas, P.C. Managerial Economics, 9th edn. Kalyani Publishers.

Food Psychology 2 (2+0)

Objectives

1. To gain an understanding of the psychological factors that influence food choices, eating behaviors, and our relationship with food
2. To explore the impact of sensory experiences (taste, smell, sight, touch) on food perception and preference
3. To examine the psychology behind food marketing and advertising strategies
4. To develop practical strategies to cultivate a mindful and healthy relationship with food

Theory

Introduction to Food Psychology, Interaction of Hunger and Satiety, Sensory Perception and Food Preferences, Role of positive and negative emotions on selection / choice of foods – eating behavior. Meal composition and effect of specific nutrients on mood / stress., Understanding and Managing Cravings, Anorexia nervosa and binge eating behaviour, Mindful Eating Practices, Social Cues and Dining Environments, Psychological influence of Food Marketing and Advertising, digital food marketing – public health challenge, Cultural Food Traditions and Practices, Food and Mental Well-being, Practical Applications of Food Psychology, Overeating, Disordered Eating, and Body Image Concerns, Strategies for Individual and Community Health.

Suggested Readings

1. Cardoz F. 2009. India: The cookbook. HarperCollins Publishers India.
2. Hardcastle SJ, Thøgersen-Ntoumani C, and Chatzisarantis NL. 2015. Food Choice and Nutrition: A Social Psychological Perspective. Nutrients. Oct;7(10):8712-5.

Physical Education, First Aid and Yoga Practices, Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (cricket, football, table tennis, badminton, volleyball, basketball, kabaddi and kho-kho) and athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Food Nutrition and Agriculture 2 (2+0)

Objectives

1. Develop skills to apply and evaluate innovative solutions that place nutrition at the heart of a sustainable food system
2. Students will learn about the components of the food system and their link to nutrition and acquire the skills to implement and evaluate nutrition-sensitive interventions

Theory

Food production and consumption situation in India and in the world; Food production and consumption trends, food balance sheets; Role of nutrition in agricultural planning and national development. Linkages between agricultural practices, food production, food distribution and nutritional status; Factors affecting food distribution at macro and micro level, per capita food availability and consumption; Food and nutrition security at national and household level; Role of agriculture in enhancing food security; Urbanization and food security. Sustainable food systems; Food crop failure and malnutrition, poverty and vicious cycle of low food production. Innovative approaches to enhance local food production and improve food distribution systems. Effect of food production and economic policies on food availability; Impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post-harvest processing of foods on food and nutrition situation; Nutritional composition of commonly consumed foods. Implementation of nutrition policy, agricultural programs; nutritional impact of agricultural programs, food price control and consumer subsidy; Contribution of National and International organization in agricultural development.

Suggested Readings

1. Albert, JL. (Ed.) 2000. Food, nutrition and agriculture. FAO Publication.
2. FAO. 2017. The State of Food and Agriculture - Leveraging Food Systems for Inclusive Rural Transformation. Food and Agriculture Organization, Rome.
3. FAO. 2017. The State of Food Security and Nutrition in the World. Food and Agriculture Organization, Rome. (latest publications of FAO)
4. GOI. 2001. India 2001. A Reference Annual. Publication Division, Ministry of Information and Broad casting, Govt. of India.

5. GOI. 2011. Census of India. Government of India. (New Census Report)
6. GOI. 2017. Agriculture - Statistical Year Book India. Ministry of Statistics and program Implementation, Government of India. (latest publications of GOI)
7. GOI. 2018. A Reference Manual by Publication Division. Ministry of Information about Broadcasting, Govt. of India.
8. Raghuvanshi R.S. 2013 Nutritional Security through Diversified Food Production. in Agrarian Change and Small Farmers, Super markets, Viability and Food Policy. Ed. by K.N. Bhatt and Pradeep Bhargava, Concept Publishing Company PVT. LTD., New Delhi
9. National Family Health Survey (rchiips.org).
10. Home - Global Nutrition Report.
11. Global Food Security Index (GFSI) (economist.com).
12. https://www.who.in.

SEMESTER IV

Normal Nutrition and Meal Planning 3 (2+1)

Objectives

1. To study general nutrition, principles of meal planning, food safety, consumer guidelines, and management techniques for lab experiences
2. To cover a variety of experiences, designed around the actual preparation of foods.
3. To cover vocabulary, reading and following recipe and/or modelled directions, selection and storage of food items, cooking methods, and related techniques
4. To successfully complete this course as it is a prerequisite to enrolment in Culinary Arts.

Theory

Basic principles of menu planning, planning menus for individual and family. Classification of vegetarianism. Factors influencing food intake and food habits. Basic principles of meal planning, planning meals for individual and family. Factors affecting food requirements of individuals, families and different groups of people. Meal planning for special occasions. Steps involved in meal planning. Food groups and their use in meal planning. Recommended dietary allowances of macro and micro nutrients for different age groups. Food exchange list. Use of food exchange list in diet planning, planning breakfast, lunch, tea, dinner, packed lunch and snacks; considering RDA for individuals Importance of balanced diets. Food and nutrient requirement of adults and diet planning (male and female of all activities level), pregnant women, lactating women, old age. Breast feeding, advantages of breast feeding, prelacteal feeding, breast feeding during illness, feeding of pre term baby, feeding problems. Complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, geriatric nutrition- physiological and psychological factors affecting the diet plan.

Practical

Standardization of serving sizes, portion, cost of locally available common foods. Food exchange list: method of using and portioning. Planning preparation and nutrient calculation of

diets of preschool children, school going children, adolescents, adults and senior citizens, packed lunches for school children. Practice in formal and informal table setting and table manners.

Suggested Readings

1. Gopalan, C. and Krishnaswamy, K. 2000. Nutrition in Major Metabolic Diseaes. Oxford University Press, New Delhi.
2. Joshi, Shubhangini A. 2021. Nutrition and Dietetics. 5th edn. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. ICMR. 2020. Recommended Dietary allowance for Indians, ICMR, Delhi.
4. Longvah, T., Ananthan, R., Bhaskarachary, K. and Venkaiah, K. 2017. Indian Food Composition Tables. National Institute of Nutrition, ICMR, New Delhi
5. Robinson and Weicley. 1984. Basic Nutrition and diet Therapy. MacMillian Publishing Co. Inc. New York and London.
6. Raghuvanshi, R.S. and Mittal, M. 2019. *Upcharatmak Poshan* (Diet Therapy) Brillion Publishing House, New Delhi pp 1-352. (Hindi)
7. Raghuvanshi, R. S. and Mittal, M. 2014. Food Nutrition and Diet Therapy. India: Westville Publishing House New Delhi.
8. Sharma, S. 2006. Human nutrition and meal planning. Delhi, Jnanada Prakasham (P and D).
9. Sehgal, S. and Raghuvanshi, R. S. 2007. Textbook of Community Nutrition. Indian Council of Agricultural Research, New Delhi.
10. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==

Public Health Nutrition 3 (2+1)

Objectives

1. To equip students with the knowledge of community nutrition, national and international nutrition programs and interventions
2. To develop, implement and evaluate the nutrition programs and policies to address the different nutritional problems with greater impact and efficiency
3. To develop an evidence-based approach to address the nutritional problems and to reduce the risk for malnutrition in different populations.

Theory

Concept of Health, Public health, Public Health Nutrition, Nutritional Epidemiology and Community nutrition- Demography, demographic cycle; Health Indicators and their significance – Birth and death rates, IMR, MMR, TFR, U5MR etc. Health Care System in India – Primary, Secondary and Tertiary, National Health Policy, National Nutrition Policy and National Nutrition Mission-An overview. Public health problems of India, nutrient deficiency diseases and other diseases, their etiology, prevalence, prevention and monitoring. Indicators and data sources from existing macro and micro systems of information in India (NFHS, NSSO, ICDS, NSS, CENSUS). National programs relevant for public health. Vitamin A deficiency disorder control program, National diarrhoeal disease program, national iodine deficiency disorder control program, iron deficiency anemia prophylaxis program, National malaria eradication program, national immunization program,

national program for control of tuberculosis, national AIDS control program, other health and nutrition programs. Communicable and infective disease control: Nature of communicable diseases, infections, contamination, transmission, vector borne diseases, environmental agents, control and prevention. National Malaria Eradication program, National Filarial control program, National Leprosy Eradication program, Japanese Encephalitis control and other national control programs (Blindness, Mental Health, etc.) National Mental Health program (NMHP. Universal Immunization program and child survival and safe motherhood program. COVID-19, its origin, life cycle of virus, mutation, detection, case tracking, vaccine development, and vaccination program. Principles and elements of public health care. Role of NNMB.

Practical

Visit to PHC to study the prevalence of the communicable disease. Epidemiological approach to study individual disease in a community. Analysis of data and report writing. Discussion for preventive and therapeutic strategies. Public health campaign in a village. Understanding the uses of screening tools.

Suggested Readings

- DeMaeyer, E.M. 1989. Preventing and controlling iron deficiency anemia through primary health care. A guide for health administrators and program managers. WHO, Geneva.
- International Institute for Population Sciences (IIPS) and ICF. 2021. National Family Health Survey (NFHS-5), 2019-21: India. Mumbai: IIPS.
- McLaren, D.S. 1976. Nutrition in the community. John Wiley and Sons, London.
- Michael, J., Gibney, Barrie, Margetts, M., Kearney, John M. and Arab Lenore. 2004.Public Health Nutrition. Blackwell Science Ltd, UK.
- Park, K. 2016. Textbook of Preventive Medicine. New Age international (P) Limited.
- Sehgal, S. and Raghuvanshi, R.S. 2007. Textbook of community nutrition, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
- Vyas, S. 2021. Public Health Nutrition: A textbook. Vishwagyan Prakashan.
- WHO 2001. Assessment of iodine deficiency disorders and monitoring their elimination. A guide for program managers 2nd edn.
- https://www.who.int/emergencies/diseases/novel-coronavirus-2019

Nutritional Biochemistry 3 (3+0)

Objectives

1. To understand the chemical characteristics of different classes of nutrients with reference to their physical properties, and to relate this to their functions in the body
2. To explain the processes of digestion, absorption and metabolism of the macronutrients and micronutrients in the context of different meals
3. To consider the main features of metabolism using the concept of energy flux through metabolic pathways as a focus

4. To explore the integration of pathways for the metabolism for fat, protein and carbohydrate and to examine the mechanisms for the regulation of flux through these pathways
5. To discuss the established functions of micronutrients and to examine the clinical and biochemical effects of depletion

Theory

Recapitulation of basic chemistry and biology Water, pH and buffers, Acid-base balance Cellular constituents, Structure and function: Amino acid and proteins, Carbohydrates, Lipids and bio membranes, Nucleic acids– Vitamins and minerals. Enzymes, function, properties, mechanism, Metabolism of cellular constituents. Basic concepts of Bioenergetics Carbohydrates metabolism: glycolysis and glycogenolysim, HMP pathway, TCA Cycle, Electron transport chain, Gluconeogenesis, Lipids metabolism: Beta-oxidation, Ketone bodies, Fatty acid synthesis. Amino acid metabolism: General reactions of nitrogen assimilation and excretion Biosynthesis of DNA, RNA and Protein replication, transcription, translation and genetic code regulation of gene expression, Enzymes - specificity, classification, factors affecting enzyme activity. Amino acid metabolism: General catabolic reactions of amino acids, Digestion and absorption. Estimation of total carbohydrates by Anthrone method, Estimation of proteins by Biuret method.

Suggested Readings

1. Conn EE and Stumpf PK. 2009. Outlines of Biochemistry. John Wiley. Y Nelson, DL and Cox, MM. 2004.
2. Lehninger. Principles of Biochemistry. 5th edn. MacMillan.
3. Voet D, Voet JG and Pratt CW. 2007. Fundamentals of Biochemistry. John Wiley y Jayaram. T. 1981. Laboratory manual in biochemistry, New Delhi: Wiley Estern Ltd.
4. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd edn. Tata McGraw Hill, New Delhi.
5. Hames BD, Hooper NM and Houghton JD. 1997. Instant Notes in Biochemistry. BIOS Scientific Publishers.
6. Satyanarayana U and Chakrapani U. 2008. Essentials Of Biochemistry.
7. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==

Food Standards and Quality Control 3 (2+1)

Objectives

1. To develop qualified and competent human resource in the field of the food standards and quality management for regulators, industry, academic/research institutions, certifying and accreditation bodies, food trade, food testing and training
2. To delve in depth on various aspects of food standards and quality management i.e. food standards, harmonization with global benchmarks, quality management systems, food analysis, instrumentation, risk analysis /management, traceability and auditing to transform the food ecosystem
3. To nurture a positive and disciplined food standard and quality culture among the professionals
4. To conduct research studies on emerging food standard issues and formulation of science based regulatory framework

Theory

Importance of food quality control and assurance. Food Standards and Regulations in India: FSSAI, Prevention of Food Adulteration Act, Fruit Product Order, AGMARK, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards, Food and Drug Administration (FDA). Food additives, preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents. Various methods for the assessment of quality of different foods. Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws Food packaging, packaging material. Adulteration, heavy metals. Quality criteria of foods – food grains, fruits, vegetables and animal foods. Quality criteria of processed foods. Physical, chemical and microbial contamination of foods. Food adulteration – common adulterants – health hazards. Tests to detect adulterants in food. Pesticides-Mechanisms of Toxicity-Residues in Food, Acceptable daily limits. FosTac - Food Safety Training and Certification, Sensory Evaluation of Food Quality – Introduction - Panel Screening - Selection of Panel Members Objective/ Instrumental analysis of Quality Control. Statistical Quality Control of Foods Determination of Sensory thresholds and taste Interactions. Fundamentals of Food regulations-pertaining to Additives and Contaminants, SOP for Milk and milk products, Meat products, Fruit and vegetable products. Safety in handling of Food Additives.

Practical

Visit to FSSAI, FCI, AGMark, Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products. Identification of food logos. Study of food labelling. Identification of critical control points in a product line. Sensory evaluation of different food samples. Visit to quality control laboratory/food processing industries and note the procedures and parameters used for quality assessment. Estimation of quality parameters- cereals, pulses, fruits and veg. Market survey and quality analysis of street foods. Estimation of quality parameters – cereals, pulses, fruits and vegetables - Evaluation of food quality – objective and subjective methods - Market survey and quality analysis of street foods.

Suggested Readings

- Detect Adulteration with Rapid Test (DART) booklet fssai https://www.fssai.gov.in/flipbook.php?bookid=201#book2/7
- Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011.
- Jellinek, G. 1985. Sensory Evaluation of Foods: Theory and Practice. Ellis Honwood Ltd. Chichester, England.
- Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised edn. Kalyani Publishers, New Delhi
- Manual of Food Standards and Quality Control. 2014. Dept. of Foods and Nutrition, CCS HAU, Hisar.
- Patricia and Cuuring A. An operational Text book, guide to Food Laws and Regulations.
- Potter, N.N. 1996. Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
- Radonit Lassztity. 2008. Food Quality and Standards. Encyclopedia of Life effort systems. USA.

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

- Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
- Dominic Salvatore, Micro Economic Theory
- Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
- Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
- Lekhi, R. K. and Joginder Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
- Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
- Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
- Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture.
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical

analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm

decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WoRD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages. Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology. Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA). AR/VR demonstration.

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al., Jain Brothers Publication.

Post- Semester IV (Only for exit option for UG- Diploma)

S. No.	Course Title	Credit Hours
1.	Internship (10 weeks)	**10 (0+10)***

*Mandatory requirement for UG-Diploma.

Details as given for Post- Semester II
SEMESTER V

Therapeutic Nutrition 4 (3+1)

Objectives

By the end of the course the students will be able to

1. Acquire basic knowledge of nutrient requirements, recommended dietary allowances, and dietary modification under different physiological conditions
2. Acquire basic knowledge of food groups, food exchange system and their nutritional significance, and application of knowledge acquired for healthy eating
3. Develop practical skills in planning and management of diets for the different age groups under normal/ physiological conditions keeping in mind the dietary guidelines
4. Gain knowledge on the nature and scope of therapeutic nutrition; and understand the principles of dietary modification and apply in planning
5. Understand nutrition-related diseases of the: gut, liver, gallbladder, pancreas, and heart
6. Know the etiology, incidence, nature, clinical symptoms, diagnosis, and medical and dietary management of disease
7. Modify the diet plans to suit the disease condition

Theory

Terminologies used in the therapeutic nutrition; Use of food groups and food pyramid. Importance and components of diet history; Different principle of therapeutic diets, Therapeutic modifications of normal diet in terms of consistency and nutrients; Normal and artificial feeding methods, Role of Dietician in medical nutrition therapy, Diet during malnutrition- undernutrition and over nutrition; Diet during infection and fever; Diet during Gastro intestinal disorder- esophagitis, diarrhea, constipation, peptic ulcers, IBD/IBS. Liver and gall bladder disorders- dietary management of jaundice, hepatitis, liver cirrhosis, cholelithiasis. Kidney disorders- dietary management of nephrosis, nephritis, renal failure, renal calculi and dialysis. Arthritis and gout, Cardiovascular disorders- dietary management of atherosclerosis, hypertension and stroke and congestive heart failure. Diabetes mellitus- dietary management during diabetes mellitus and complications, glycemic index and glycemic load of food items. PCOD/PCOS: etiology, signs and symptoms, types, risk factors and dietary management. Cancer- dietary management; Inborn errors of metabolism; allergies and intolerance, burns and trauma; Common auto immune diseases/ disorders.

Practical

Planning of food exchange list, taking diet history. Planning and preparation of diet modified in consistency and nutrients for severely ill patients. Plan a diet for artificial feeding patients. Plan a diet patient with malnutrition, infections and fevers - PEM, typhoid, tuberculosis, influenza. Plan a diet for a patient with during atherosclerosis, hypertension. Plan a diet for patient with diarrhea, constipation, peptic ulcers and esophagitis. Plan a diet for a patient suffering from liver cirrhosis, jaundice, hepatitis and cholelithiasis. Plan a diet for a diabetic patient. Plan a diet of a patient renal failure, renal calculi. Plan a diet for a patient with cancer.

Plan a diet for patient with lactose intolerance and celiac diseases.

Suggested Readings

- Corinne H. Robinson, Marilyn, R. Lawler, Wanda L. Chenoweth and Ann E. Garwick. 2013. Normal and therapeutic Nutrition (pp-1-16). New York, Macmillan Publishing Company.
- Mahan, L.K. and Escott-Stump, S. 2000. Krause's Food, Nutrition and Diet Therapy, W.B. Sanders Company, Philadelphia.

- National Institutes of Health Diet History Questionnaire. Diet History Questionnaire (nih.gov)
- Raghuvanshi, R. S. and Mittal, M. 2014. Food Nutrition and Diet Therapy. India: Westville Publishing House New Delhi.
- Raghuvanshi R.S. and Mittal M. 2016. Clinical Nutrition *Chikitskeey Poshan*. Vikas Publishing House Pvt. Ltd. New Delhi.
- Sharma, A. 2017. Principles of Therapeutic Nutrition and Dietetics. CBS.

Food Analysis 3 (2+1)

Objectives

1. To impart knowledge to students on principles and techniques of food analysis by using physical, chemical, biological methods
2. To apply their knowledge and skills acquired to solve real-world problems associated with food analysis

Theory

Terminologies associated with food analysis, Rules and regulation of food analysis. Different official methods of analysis. Familiarization to terms and calculations used in preparation of various standard solutions. Sample and sampling techniques. Principles, techniques and applications of: spectrophotometer, colorimeter, pH meter, refractometer, electrophoresis, centrifuge, HPLC, GLC, TLC, GCMS, UPLC, AAS, AES. Proximate composition analysis methods. Moisture analysis- direct and indirect methods of analysis. Protein analysis method – dumas, Biuret, Lowry's, dye binding and Spectroscopy method, amino acid analyzer. Mineral analysis- dry ashing, wet ashing, titrimetric, gravimetric, colorimetric and instrumental methods-AAS, AES. Physical characteristic of foods, rheological properties of food. Anti-nutrients in foods: phytate, tannins, oxalates, saponins, trypsin and chymotrypsin. Animal assay: Principles, techniques and applications. Principles for estimation of water- and fat-soluble vitamins.

Practical

Orientation of food analysis laboratory. Calculation and preparation of various standard solution. Preparation of sample for food analysis. Proximate composition of analysis- moisture, Kjeldahl method of protein analysis, Fat analysis – soxhlet, soxplus, estimation of free fatty acid (FFA), ashing and CHO by difference. Estimation of sugar, reducing and non-reducing sugars and starch. Mineral analysis- iron, calcium. Testing acidity of foods. Estimation of anti-nutrients: phytate/tannins/oxalates/saponins. Estimation of rancidity in foods and peroxide values. Functioning and use of HPLC, GLC and pH meter, GCMS, UPLC. Visit to food quality control lab.

Suggested Readings

1. AOAC.2012. Association of official analytical chemists. Washington, DC.
2. Nielsen. S. 2010. Food Analysis, Springer Science and Business Media Pub.
3. Oser, B.L. 1979. Hawk's physiological chemistry. Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
4. Pearson, D. 1973. Laboratory Techniques in Food Analysis. United States: Wiley.

5. Pomeranz, Y. 2013. Food Analysis: Theory and Practice. United States: Springer US.
6. Raghuramulu, N., Madhavan Nair, K. and Kalyanasundaram, S. 2003. A manual of laboratory techniques. National Institute of Nutrition (India).
7. Ranganna, S. 2000. Handbook of Analysis and Quality Controlfo Fruit and Vegetable Products. Tata McGraw-Hill.

Current Food Processing Technologies 3 (2+1)

Objectives

1. To explain major food preservation techniques and underlying principles
2. To understand the technology available for food processing
3. To determine suitable methods of processing techniques for a chosen food
4. To understand novel food processing methods including non-thermal food processing techniques
5. To understand the purpose and principles of food packaging
6. To develop an understanding of major packaging materials used in food packaging
7. To evaluate the suitability of packaging material for a particular type of food
8. To understand the operations involved in packaging material manufacture
9. To gain knowledge of the legal, environmental and quality aspects associated with packaging materials and operations used in the food industry

Theory

Current scenario in food processing industry, post-harvest loss and losses in post-harvest operation. Upcoming trends in food processing-thermal treatment, ultrasound, freezing, pulse electric field, shockwave technology. Minimal processing- application of Ultra sonic food processing techniques – membrane processing – applications in food processing industries – robotics – applications and opportunities – issues and obstacles Food preservation using chemicals, radiation and hurdle technology. Nanotechnology in food preservation, food processing, agriculture and in packaging. Processing of convenient cereals and millets, processing of pulses and legumes, oilseed processing. Principle and method of preservation by- pasteurization, canning, bottling, sterilization. Advance dehydration technologies- Freeze drying, microwave dehydration, electric dehydrator, osmotic dehydration, hybrid drying technologies, vacuum drying methods, spray drying methods. High pressure processing- principle, safety and stability of high-pressured processed food. Encapsulation technology – principle, mechanism involved, encapsulation agents and uses. 3D printing and application in food manufacture. Government policy on import and export of processed fruits and vegetables.

Practical

Processing of breakfast cereals, Processing of pulses into flour, flakes and fermented Demonstration of dehydration of foods via- freeze drying, osmotic dehydration, spray drying, vacuum drying, microwave dehydration. Processing of fruits and vegetables via- canning using brine and syrup. Blanching in food items. 3D printed foods. Preservation using pasteurization and sterilization. Visit to food processing unit and nanotechnology lab

Suggested Readings

- Chakraverty (1995). Post-harvest technology of cereal, pulses and oilseeds, 3rd edn. Oxford and IBH publishing co., Pvt. Ltd.
- Fellows PJ (2017). Food Processing Technology, Principles and Practice.4thEdition, Wood head Publishing Ltd. Cambridge.
- Hartel R W and Heldman D (2012). Principles of Food Processing. Aspen Publishers Inc. New York.
- Potter N N (2003). Food Science, AVI publishing company, INC, West Port, Connecticut.
- Shafiur Rahman M (2007). Hand book of food preservation. 2nd edn. Published by CRC Press, London.
- Sivshankar B (2002). Food Processing and Preservation. Prentice-Hall of India Pvt. Ltd. Delhi.
- Srivastava R P and Kumar Sanjeev (1994). Fruit and vegetable preservation, International book distributing Co. Lucknow.

Statistical Methods 3 (2+1)

Objectives

1. Organize, manage and present data
2. Analyze statistical data graphically using frequency distributions and cumulative frequency distributions
3. Analyze statistical data using measures of central tendency, dispersion and location
4. Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events
5. Translate real-world problems into probability models
6. Derive the probability density function of transformation of random variables
7. Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables
8. Analyze Statistical data using MS-Excel

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 × 2 Contingency Table. Introduction to Analysis of Variance, Analysis of One-Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data)

with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 × 2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested reading

- Agarwal, B. L. 2006. Basic Statistics. New Age International Publisher.
- Sprent P. 1993. Applied Non-Parametric Statistical Methods. 2nd edn. Chapman and Hall.
- Wetherill GB. 1982. Elementary Statistical Methods. Chapman and Hall.
- William S. Cleveland (1994) The Elements of Graphing Data, 2nd edn, Chapman and Hall

Diet and Nutrition Counselling 2 (0+2)

Objectives

1. To understand, critically assess and know how to use and apply information sources related to nutrition, food, lifestyle and health
2. To be able to provide nutrition counselling and education to individuals, groups, and communities throughout the lifespan using a variety of communication strategies

Practical

Qualities of counsellor (confidence, knowledge, communication skills, patient listener, empathetic. Self- assessment of role as a dietitian – Pre-test on role, summary of competencies. Developing diet history questionnaire and taking diet history. Preparation of standard protocol based on case studies and group discussion. Preparation of overweight and underweight fact list handout and development of counselling guidelines for weight loss and weight gain. Weight loss counselling – Use of role play technique, counselling on diet, exercise and life style Visit to hospitals with therapeutic kitchen setup. Diabetic diet counselling development of dietary fat facts list, cholesterol facts list, sodium facts list. Development of dietary counselling tips for different cardiovascular disorder and counselling; cardiac patients using role play technique, presentation in gathering. Diet exhibition cardiovascular disorders in a specialty hospital / general hospital, preparation of handouts on ulcer facts list, high fibre facts list, low residue facts list, low lactose facts list, counselling for patients suffering from diarrhoea, constipation, gastro-esophageal reflex (GERD, colitis, diverticulosis and ulcer. Preparation of SOAP notes and gall bladder facts list handout and counselling a patient of gall stones. Preparation of liver disease facts list handout, collection of case history of patient suffering from hepatitis, cirrhosis of liver, alcoholics. Counselling the patient and conducting group discussion. Preparation of kidney disease facts list handout and development of counselling tips for kidney disorders, dietary counselling in a specialty hospital / diet and nutrition counselling centre for kidney disorder and diet exhibition for kidney disorder. Preparation of cancer facts list handout, Preparation of list of parenteral and enteral products available in the market for use during counselling. Setting up a unit for nutrition counselling. Role play exercises for counselling. Supervised counselling of patients/clients.

Suggested readings

- Antia, P. 1986. Clinical dietetics and nutrition. Oxford univ. Bombay.
- Corinne, H. Robinson, Lawler, Marilyn R., Chenoweth, Wanda L., Garwick, Ann E. 1982. Normal and Therapeutic Nutrition. (Pp- 1-16). New York, Macmillan Publishing Company
- Moris, E.S. 1994. Modern nutrition in health and disease. Leaned Febiger, USA.
- ICMR. 2020. Recommended Dietary allowance for Indians, ICMR, Delhi.
- Park, K. 1997. Textbook of Preventive and Social Medicine. 1st edn. Jabalpur: Banarsidas Bhanot.
- Raghuvanshi, R. S. and Mittal, M. 2014. Food Nutrition and Diet Therapy. India: Westville Publishing House, New Delhi.
- Raghuvanshi R.S. and Mittal M. 2016. Clinical Nutrition *Chikitskeey Poshan*. Vikas Publishing House Pvt. Ltd. New Delhi.
- https://aghealth.nih.gov/collaboration/qx/dhq.pdf.
- DietaryGuidelinesforNINwebsite.pdf.

Nutraceuticals and Health Foods 2 (2+0)

Objectives

1. To provide an overview of the field of functional foods, nutraceuticals and natural health products
2. To understand the functional food concept as related to ingredient efficacy and safety
3. To familiarizes students with: examples of bioactive ingredient-disease relationships and the importance of clinical study support; regulatory aspects of functional foods; requirements for standards of evidence of efficacy for health claims; and market determinants of the functional food industry

Theory

Nutraceuticals and functional food definition, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues including CODEX, FSSAI Regulation. Classification of nutraceutical substances based on food sources and based on mechanism of action, and based on chemical nature. Nutrition claims by FSSAI. Regulatory issues for nutraceuticals including national and international standards. Potential health benefits of major nutraceuticals, omega-3, lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc, Metabolism, bioavailability and pharmacokinetics of nutraceuticals. Concept of angiogenesis, nutraceuticals for joint heath, cardiovascular diseases, cancer, diabetes, obesity, eye health, cholesterol management. mental health, immune enhancement, age-related macular degeneration, endurance performance and mood disorders. Clinical testing of nutraceuticals and health foods - interactions of prescribed drugs and nutraceuticals; adverse effects and toxicity aspects of nutraceuticals; Nutrigenomics – an introduction and its relation to nutraceuticals. Current research in functional foods.

Suggested Readings

1. Robert EC. 2013. Handbook of Nutraceuticals and Functional Foods. 2nd edn. Wildman. CRC Press.

2. Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016.
3. Microsoft Word - 5925gi.doc (fssai.gov.in)
4. Rotime E Aluko. 2012. Functional Foods and Nutraceuticals. Springer Publ.
5. Saarela M. 2011. Functional Foods. 2nd edn. Elsevier Publ.
6. Sarkate AP, Patil MA and Aghar de PV. 2021. Nutraceuticals and Human Health. Brillion Publishing.

Introduction to Clinical Nutrition 3 (2+1)

Objectives

1. To acquire a basic understanding of the various clinical changes related to nutrition, which are seen in different diseases, both deficiency and otherwise
2. To understand the etiology, prevalence, clinical signs and symptoms of nutritional deficiency diseases (Vitamin A deficiency, anemia, IDD, PEM etc.)
3. To gain understanding of physiology in health and pathophysiology in disease complications occurring in various conditions and the inter relationships thereon

Theory

Metabolic changes and clinical diagnosis in various diseases: Nutrient deficiency diseases like Anemia, vitamin B complex deficiencies, Vitamin A deficiency disease, Iodine deficiency disorders, Calcium and vitamin D deficiency diseases, ascorbic acid deficiency. Metabolic changes and clinical diagnosis in degenerative diseases: Diabetes, Cardiovascular diseases, renal disorder, liver diseases, cancer. Normal cut-off values for blood and urine parameters. Interpretation of report of blood and urine in different disease conditions. Drug and nutrient interaction, effect of drugs on nutritional status. Effect of diet and nutritional status on drug effectiveness. Depletion and repletion studies; Nutrient balance studies; Use of isotopically labelled nutrients. Nutrition screening and assessment methods (Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA), Patient-Generated Subjective Global Assessment (PG- SGA), Malnutrition Universal Screening tool (MUST), disease specific tools. Nutrition care process- Assessment, Diagnosis, Interpretation, Monitoring, and Evaluation (ADIME).

Practical

Identification and interpretation of clinical signs of nutritional deficiency diseases- sampling of blood and urine for nutritional status, estimation of hemoglobin. Estimation of glucose in blood and urine in normal and diabetic persons. Estimation of lipid profile in normal and heart patients. Estimation of Glycosylated Hemoglobin, Estimation of serum total protein and serum albumin, visit to a clinical laboratory.

Suggested Readings

1. Bamji, M.S, Krishnaswamy, K. and Brahmam, GNV. 2019. Textbook of Human Nutrition. 4th ed. Oxford and IBH Publishing Co Pvt. Ltd
2. Connie, W. B. and Christine, S. R.2016. Handbook of Clinical Nutrition and Ageing. Humana Press.

3. Gibney, M. J., Elia, M., Ljungqvist, O. and Dowsett, J. 2013. Clinical Nutrition. Wiley Blackwell Publishing Company, Boston.
4. Gibney, M. J., Macdonald, I. A. and Roche, H. M. 2011. Nutrition and Metabolism. Wiley Blackwell Publishing Company, Boston.
5. Gopalan C. and Krishnaswamy K. 2000. Nutrition in Major Metabolic Diseaes. Oxford University Press, New Delhi
6. Joshi, Y.K. 2004. Basics Of Clinical Nutrition. Jaypee Brothers
7. Lee, R.D. and Nieman, D.C. 1993. Nutritional assessment. Pub. Brown and Benchmark, USA.
8. Pathak, N.N. 1997. Analytical techniques in clinical nutrition (manual); Centre of Advanced Studies in animal nutrition IVRI, Izatnagar.
9. Oser, B.L. 1979. Hawk's physiological chemistry. Tata Mc Graw Hill Pub. Co. Ltd., New Delhi
10. Raghuvanshi, R. S., Mittal, M. 2014. Food Nutrition and Diet Therapy. India: Westville Publishing House New Delhi.
11. Width, M. and Reinhard, T. 2017. The Essential Pocket Guide for Clinical Nutrition. LWW Pub.
12. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==

Educational Tour (Non-gradial) **2 (0+2)**

Semester VI

Food and Nutrition Security **2 (1+1)**

Objectives

1. To explain the concepts of food and nutrition, malnutrition, food security and livelihoods. Understanding these concepts is important to assess the nutrition situation, design and implement programs, investments and policies that address nutrition problems (also called nutrition- sensitive), and evaluate the nutritional outcomes of programs, investments and policies.
2. To introduce the concepts and tools used in food security analysis. It defines food security and its relationship to the concepts of vulnerability, hunger, malnutrition and poverty
3. To provide guidelines on how to interpret and use conceptual frameworks for analyzing food security

Theory

Food Security: Concept and definition, pillars and determinants. Global Food Security Index. Global hunger index and its indicator and how they measured. Global challenges to food and nutrition security. Inter- relationship between hunger and food insecurity. Strategy to achieve food security at household, national and global level. Role of nutrition in human health and sustainable development. Relationship between nutrition, diet and lifestyle. Growing global concern for non-communicable diseases. Opportunities and challenges of nutrition and food preferences as a means of preventing the spread of chronic and non- infectious diseases. Impact of social, cultural and economic factors on the food and nutrition security. Nutrition security: Concept and definition,

pillars and determinants. Nutrition sensitive approaches to combat malnutrition. Dietary diversity for nutrition security. Dietary diversification through utilization of bio-fortified crops, indigenous and under-utilized foods. Millennium Development Goals, Sustainable Development Goals (SDG) II and way ahead. National and international policies and programs related to food and nutrition security: POSHAN Abhiyan, NARI (Nutri-sensitive Agricultural Resources and Innovations), NFSA (National Food Security Act), NFSM (National Food Security Mission), NNM (National Nutrition Mission), WFP (World Food program), FAO (Food and Agricultural Organization). Public distribution system in context to food and nutrition security, International Fund for Agriculture Development (IFAD) etc.

Practical

Household survey for assessment of indicators of Food insecurity. Proforma dev, survey, report writing, validation. Assessment of dietary diversity, quality, food security, nutrition security. Food product development and formulation for intervention of nutri-sensitive approaches and strategies to eradicate poverty and malnutrition. Impact of nutritional policies and programs on the nutritional status of the vulnerable group. Framing questionnaire to conduct dietary survey – using Food Frequency Questionnaire.

Suggested Readings

- Coates et al. 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Version 3.
- Ruel, M. T., Garrett, J., Yosef, S., and Olivier, M. 2017. Urbanization, food security and nutrition. Nutrition and health in a developing world, 705-735.
- Pingali, P., Alinovi, L., and Sutton, J. 2005. Food security in complex emergencies: enhancing food system resilience. Disasters, 29(s1), 5-24.
- Raghuvanshi R.S. 2013. Nutritional Security through Diversified Food Production. In Agrarian Change and Small Farmers, Super markets, Viability and Food Policy. Ed. by K.N. Bhatt and Pradeep Bhargava, Concept Publishing Company PVT. LTD., New Delhi
- Sunderland, T., Powell, B., Ickowitz, A., Foli, S., Pinedo-Vasquez, M., Nasi, R., and Padoch, C. 2013. Food security and nutrition. Center for International Forestry Research (CIFOR), Bogor, Indonesia.
- Swindale, A., and Bilinksy, P. 2006. Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide. Vol. 2. Washington, D.C.: FHI 360/ FANTA.
- Willett, W. 2013.Nutritional Epidemiology, Oxford University Press.

Nutrition, Body Composition and Physical Fitness 3 (2+1)

Objectives

1. To provide understanding of the interactions between nutrition and exercise by integrating metabolism and physiology concepts in the context of recreational physical fitness training
2. To identify and describe disordered eating and exercise patterns
3. To gain an understanding of the training and experience necessary to obtain various nutrition and exercise credentials

Theory

Body composition, methods of assessment- tools and techniques, changes in Body composition with age and fitness. Interrelationship between physical fitness and performance. Basic structure of a muscle with the help of a diagram - Functions and locations of muscles in the body - muscle groups –Major skeletal muscles. Basics of exercise regime - FITT formula – Frequency, Intensity, Time and Type of exercises for fitness. - Warm up exercises - Cool down exercises: Exercises - Benefits of regular and adequate exercise - Types of exercises and health benefits with suitable examples. Anaerobic exercises Flexibility exercises. Effect of nutrition in physical fitness and sports performance and athletics. Concept of energy balance - factors affecting energy – equations to assess BMR. . Aerobic exercise to increase cardiovascular endurance – benefits and examples -Treadmill, Elliptical cycle, Stationary cycle. Aerobics workouts Macronutrients metabolism in exercise – Carbohydrates: lactose intolerance, Diabetes, hypoglycemia; Lipids and Oils, Fatty Acids, Triglycerides, Phospholipids, Sterols. Functions of fats, needs, deficiencies. Role of water and electrolytes in performance. Vitamins metabolism in sports - Free radicals in exercise role of antioxidants in exercise - Minerals and trace minerals metabolism in exercise and essential minerals and trace minerals in sports. Sports nutrition products - supplements related to energy metabolism - weight reduction and botanical and herbal supplements - sports nutrition theory to practice –, Special consideration in sports nutrition- Women, young, diabetic, vegetarian athletes - Sport specific nutrition – Gymnastics, weight lifters, skiers, cyclists, swimming, skating, Winning recipes for peak performance. Assessment of Physical fitness Functional tests: Cardiorespiratory and muscular assessment; Type of measurement and protocol for evaluation and interpretation of performance; Aerobic Power or VO2max; Anaerobic Threshold; Economy of Movement. Fitness assessment: Types of exercise, Components of physical fitness and its evaluation in health and performance. Activity Recording: Self-reporting of activities vs. Direct monitoring of activities. Techniques to measure energy expenditure and energy intake. Techniques to assess physical fitness. Aging theories, physiology, mechanism and role of nutrients in arresting aging process.

Practical

Recording of Dietary intake by 24-hour recall method for 3 consecutive days. Recording of energy expenditure by 24-hour recall method by using multipliers for 3 consecutive days. Calculation of energy balance by using above data. Demonstration and use of body composition analyzer calculation of total fat and fat free muscle mass. Calculation of fat % and BC of adults, equations to assess BMR. Physical tests: Harvard STEP test, Treadmill test to assess heart health, muscular grip test. Visit to established fitness center.

Suggested Readings

1. Falkner, F. and Tanner, J. M. 1978. Human growth - Principles and prenatal growth. Vol. I.
2. Falkner, F. and Tarnner, J. M. 1980. Human growth methodology. Ecological, genetic, and nutritional effects on growth. Vol. III. Plenum Press.
3. Heather, Hedrick Fik and Mikesky, Alan E. 2015. Practical Application in Sports and Nutrition. 4th edn. Jones and Bartlett Learning, Burlington, MA 01803.
4. Srilakshmi, B., Suganthi, V., Ashok and Kalaivani, C. 2017. Exercise Physiology Fitness and Sports Nutrition. 1st edn. New Age International (P) Ltd. Publishers, New Delhi.
5. Tindall, Falkner F and Tarnner, JM. 1980. Human Growth Methodology.

6. https://egyankosh.ac.in/bitstream/123456789/42208/3/Unit-3.pdf

Food Microbiology 3 (2+1)

Objectives

1. To understand scope of food microbiology and food safety
2. To understand important genera associated with food
3. To learn techniques for enumeration of microbes and methods (traditional to advanced) for preserving food
4. To understand role of different microorganisms in food spoilage, food fermentation and food-borne diseases
5. To learn about microbiological quality control and food-borne illnesses investigation procedures for ensuring food safety and hygiene
6. To learn food safety rules and regulations, Food Safety Management System (FSMS), and Microbiological Risk Assessment

Theory

The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Difference between prokaryotic and eukaryotic cells. Basic aspects and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in foods. Food preservation - Physical methods. Chemical preservatives and natural antimicrobial compounds, biology-based preservation system. Importance and scope of microorganisms in food. Primary sources of microorganisms in food. Assessment of microbial load in foods-microscopic, cultural, immunological and DNA based methods. Fermentation: methods, applications, fermented foods. Lactic acid bacteria – production of cultures for food fermentation. Fermented foods- cereals, dairy products, vegetables and fruits. - bread, beer, yoghurt, butter, cheese, kefir, kumiss, sauerkraut, olives, pickles, wine, vinegar. Control of microorganisms by use of low and high temperature, asepsis, water activity, drying, preservatives, radiation and pressure for control of microorganisms; Microbiology of milk and milk products; Sources of contamination, spoilage and prevention; Microbiology of fruits and vegetables; cereal and cereal products; meat and meat products; fish and other sea foods; poultry and eggs; sugar and sugar products; salts and spices; contamination, spoilage and prevention. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; chemical changes caused by microorganisms; control of spoilage. Food borne diseases and safety measures. Present problem in food production / food processing / fresh food handling industries are facing several restrictions in different stages both from domestic and global players and consumers.

Practical

Changes in practices: General laboratory practices in microbiology laboratory, Equipment used in food microbiology laboratory, Aseptic methods, Sterilization methods, Morphological studies, Preparation of media, Isolation and enrichment of microorganisms, Microbial analysis of food products and water. Isolation of molds from foods. Microbial examination of cereal and cereal products, vegetable and fruits, meat and meat products, fish and other sea foods, Eggs and poultry, milk and milk products; sugar, salts and spices. Preparation of fermented whey beverages.

Suggested Readings

1. Adams, MR and Moss MO. 2008. Food Microbiology, 3rd edin, RCS publishing, UK
2. Frazier J and Westhoff DC. 2017. Food microbiology. 5th edn. McGraw Hill.
3. Jay JM, Loessner MJ and Golden DA. 2005. Modern food microbiology. 7th edn. Springer.
4. Ray B. 2004. Fundamentals of food microbiology.3rd edn. CRC.
5. Steinkraus, KS. 1996. Handbook of Indigenous Fermented Foods. Marcel Dekker
6. http://www.gitam.edu/eresource/environmental/em_maruthi/food.htm
7. http://www.cdc.gov
8. http://www.asm.org/division/w/web-sites.htm
9. http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/UCM297627.pdf

Milk Processing and Technology 3 (2+1)

Objectives

1. To understand chemistry of milk constituents. Milk and various dairy products are discussed from the perspective of the chemical, physical and biological changes that occur during processing
2. To be able to describe the composition of milk, identify the approximate content of individual types present, and describe physicochemical characteristics of the main components
3. To learn to integrate knowledge of food chemistry/engineering/microbiology and physical properties of foods to understand the processing of dairy products
4. To be able to explain how dairy products (such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved

Theory

Introduction, importance and scope of fluid milk industry in India and abroad: Brief history and present status. Composition of milk, nutritive value of milk of cow and buffalo. Physico-chemical properties of milk and milk constituents: Physical state, acidity, pH, density and specific gravity, freezing point, color and flavor. Microbiology of milk. Types of microorganisms, their production and consequent results in milk production. Types of milk: Sterilized Milk; Homogenized Milk; Flavored Milks; Standardized Milk; Reconstituted/Re-hydrated Milk; Recombined Milk; Toned Milk. Milk products- traditional products- butter, ghee, khoa, cheese in theory. Steps of milk processing: collection, chilling, standardization, pasteurization, homogenization, bactofugation, and principles of dehydration. Management of processing plant: Various kinds of designs and layouts of plants Value addition for fluid milk. Fortification of milk Waste management, Quality control aspects of milk: Status of antibiotics, pesticides, heavy metals etc., good manufacturing practices, implementation of HACCP standards, cleaning and sanitization of fluid plant: Indian standards for milk and milk products as per PFA, BIS, AGMARK etc., cleaning and sanitization procedures. Judging and grading of milk, defects in milk, their causes and prevention.

Practical

Platform test of raw milk (clot on boiling (COB) test, alcohol test). Adulteration in milk and its detection. Sampling of milk. Estimation of fat, SNF, TS platform tests. Cream separation. Detection

of adulterants Microbiological quality evaluation of milk and milk products Preparation of milk products. Paneer, chenna, ice-cream, khoa, burfi, flavored milk, rasogulla. Visit to modern milk processing and manufacturing plants.

Suggested Readings

1. Aneja R.P., Mathur B.N., Chandan R.C. and Banerjee A.K. 2002. Technology of Indian milk products. Dairy India Yearbook
2. Lampert L.M. 1970. Modern dairy products. Chemical Publishing Company Inc. New York
3. Srinivasan M. R. and Anantkrishanan C.P. 1964. Milk Products of India
4. Sukumar De. 2001. Outlines of dairy technology Oxford Uni. Press New Delhi
5. Swarup A. 2013. Milk processing technology. Discovery publishing house pvt. ltd.

Cereals and Millets: Processing and Technology 3 (2+1)

Objectives

1. To create understanding about the processing of major cereals like paddy, maize etc.
2. To study the storage and handling techniques of cereals
3. To study about the byproducts obtained during processing along with their uses
4. To gain knowledge on processing and milling of pulses

Theory

Production and consumption scenario of cereals and millets; Structure, Chemical composition and nutritive value of cereals and millets. General unit operations in agricultural process engineering and importance of these unit operations in grain processing, Structure and composition of cereals, millets. Morphology, physico-chemical properties of cereals, major and minor millets, Chemical tests- sedimentation test, flour swelling volume; Conventional and modern milling technology of paddy processing, estimation of milling efficiency, quality characteristics of milled cereals and millets. Parboiling of rice, bran stabilization and methods. Wheat milling and processing: purification and reduction system. Different types wheat flour, Quality characteristics of flour. Characteristics of wheat flour suitable for baking. Milling and processing of oats, corn, barley, sorghum. Primary and secondary products of cereal processing. Processing of breakfast cereals: flaked, puffed, expanded, extruded and shredded. Malted cereals and cereal products. By-products of cereals and millets processing. Structure and composition of major millets - maize, sorghum - wet and dry milling methods - processing and by products. Composition of minor millets – pearl millet, finger millet, little millet, kodo millet, foxtail millet and barnyard millet. Processing of minor millets. Structure, composition and processing of oats and barley. Malting of cereals and millets - production of weaning and supplementary foods, nutrient dense foods – amylase rich foods (ARF).

Practical

Study of physicochemical properties of cereals; Parboiling of paddy; Cooking quality of rice, milling of rice; Conditioning and milling of wheat; Production of cereal flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of cereal malt. Determination of gelatinization temperature by amylograph; Processing of value-added products from millets. Estimation of gluten content in wheat flour. Preparation of snacks based on cereals and millets (roasting, popping,

pearling, flaking, malting). Study of different unit operations and machineries in rice mills; wheat/ flour mills; Study of extrusion process.

Suggested Readings

1. Chakraverty A and Singh R P. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
2. Chakraverty A, Arun S, Mujumdar G S. Raghavan Vijaya and Hosahalli S Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. Dash S K, Bebartta J P, Kar A. 2012. Rice Processing and Allied Activities. Kalyani Publishers, New Delhi
4. David A V, Dendy and Dobraszczyk Bogdan J. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
5. Khader V. 2001. Text book of Food Science and Technology. Directorate of Information and Publications of Agriculture, ICAR, Krishi Anusandhan Bhawan, Pusa, New Delhi.
6. Khan K and Shewry P R. 2009. Wheat: Chemistry and Technology. 4th edn. AACC International, Inc., St. Paul, MN, USA.
7. Manay N S and Shadakshara swamy M. 2001. Foods facts and principles. Wiley Eastern Ltd. New Delhi.
8. Pillayar P. 1988. Rice: Post Production Manual. Wiley Eastern Limited.

Sustainable Nutrition 3 (2+1)

Objectives

1. To explore the relationship between health, nutrition, environment and sustainability
2. To investigate the potential causes of unhealthy eating patterns
3. To discover the importance of a sustainable diet

Theory

Sustainable development goals and sustainable nutrition. Definition of sustainable diets, dimensions of sustainable diets. Aims and guiding principles of sustainable diets. Climate change and sustainable and healthy diets. Indicators and measures of sustainable diets. Assessing the environmental impact of diet. Nutritional indicators of sustainability. Sustainable diet: Social and cultural perspective. Sustainable diets and food-based dietary guidelines. Traditional food at the epicentre of the sustainable food system. Determinants of food choice and dietary change. Organic food and sustainable nutrition. Indian diets and sustainability. Attaining healthy and sustainable diets. Economics, food waste, biodiversity, The environmental impact and sustainability of existing food systems. Sustainable Healthy Diets: Models and Measures - the dietary dimension, the economic dimension, the sociocultural domain, the environmental domain. Metrics for Characterizing Sustainable Nutrition Security: Nutrient Adequacy of Foods, Diets and the Food Supply, Ecosystem Stability, Food Affordability and Availability, Sociocultural Wellbeing, Resilience, Food Safety, Waste and Loss Reduction.

Practical

Develop a meal plan for nutritional adequacy and sustainability; Undertake a market survey of food products with sustainable or climate-friendly labels; Assess the 7-day food menu served in university hostels in terms of sustainability; Pilot study on assessment of food choice motives of university students.

Suggested Readings

- Burlingame, B. and Dernini, S. (Ed.). 2019. Sustainable diets linking nutrition and food systems. Wallingford, Oxfordshire; Boston, MA: CABI.
- Contento, I. R. 2011. Overview of Determinants of Food Choice and Dietary Change: Implications for Nutrition Education. In *Nutrition education: Linking research, theory, and practice* (2nd ed., pp. 26–42). Jones and Bartlett Publishers.
- FAO. 2012. Sustainable Diets and Biodiversity—Directions and solutions for policy, research and actions (Proceedings of the International Scientific Symposium Biodiversity and Sustainable Diets United Against Hunger). Food and Agriculture Organization of the United Nations. www.fao.org/3/i3004e/i3004e00.htm
- FAO, and WHO. 2019. Sustainable healthy diets – Guiding principles. www.fao.org/3/ca6640en/ca6640en.pdf.
- Sarilo, S. 2018. Towards Healthy and Sustainable Diets: Perspectives and Policy to Promote the Health of People and the Planet. Springer Briefs in Public Health. Switzerland.
- https://www.kerry.com/content/dam/kerry/sustainability/people/nutrition-health/Sustainable-Nutrition- Profiling-Whitepaper.pdf

Hospitality Management 2 (1+1)

Objectives

1. To develop industry-ready professionals for the hospitality sector
2. Gear students for operational and supervisory roles in all sectors
3. Prepare students for each food production and service roles

Theory

Food preparation- Principles of food purchasing, Methods of food purchasing; Storages of foods; Different kitchen equipment- Heavy and Light equipment, Care and maintenance and their use; Management- Principles of management, Steps of effective management, techniques of effective management; Attitude towards work, behavior and personal hygiene, Do's and don'ts while working in the kitchen; Understanding the functioning of Food Production Dept. in any catering establishment / setup- Organizational structure, layout, Duties and responsibilities; Menu planning- Definition and Principles of menu planning, Types of menus; Financial management- Introduction, Principles, Costing, Budgeting. Accounting. Food cost control methods, Factors affecting food cost, labour cost, operating cost and overhead cost; Standardization of recipe- Definition of standardization of recipe, Standard recipe format and uses, portioning equipment, portion control; Personnel management- Introduction, Personal management concepts. Staff employment, Employee benefits, Methods of selection, Orientation, Training and development, Supervision, Motivation of employees.

Practical

Menu planning for industrial canteen/ hospital canteen/ cafeteria/ snack bar/ residential hostel. Standardization of recipes suitable for fast food outlet/ industrial canteen/ hospitals/ college hostel. Multiplication of standard recipes for quantity food production, quantity food management, portioning and fixing of cost. Visit to any one canteen attached to hospital and dietary department cafeteria, 3-star hotel/restaurant, 5-star hotel / restaurant, industrial canteen. Presentation of report on hospital canteen, cafeteria, 3-star hotel / restaurant, 5-star hotel / restaurant in terms of organizational set up, production, preparation and service. Calculate food cost, labour cost, operating cost and overhead cost of any standardized recipe.

Suggested reading

- Gregoire, MB. 2017. Foodservice Organizations: A Managerial and Systems Approach, 9th ed. Food Service in Institutions. John Willey.
- Sethi and Malhan. 1993. Catering Management: An Integrated Approach. Wiley Eastern.

Food Hygiene and Sanitation 2 (1+1)

Objectives

To present the rules of personal hygiene and the importance of adhering to safety rules and regulations

1. To introduce the causes and prevention of food poisoning and to introduce the requirements of safety in the workplace
2. To introduce local legislation relating to the food service industry

Theory

Meaning and principle of food hygiene. Interrelationship of health, hygiene and sanitation Food Hazards. Personal hygiene. Water Requirement and use, sources of water supply, water pollution, purification of water, portable water and its Quality-Criteria and standards, hardness of water and its treatment, defluorination of water. Food hygiene: Contamination of foods from various sources. Green plants and fruits, animals, sewage, soil, air and water and their health hazards. Food spoilage. Perishable, semi perishable and non-perishable foods. Sanitary procedures for preparation, handling and storage of foods Food borne infection and intoxication. Food poisoning caused by bacteria: *Salmonella, Staphylococcal poisoning, Botulinum, Clostridium perfringens* and *B. cerus*. Sources, incubation period, mechanism of action. Investigation of Food Poisoning, prevention and control. Food Poisoning caused by agents other than microorganism. Poisonous plants, animals, chemicals, metals and pesticides etc. Pests and Rodent Control. Hygiene Requirements for Licensing and Sale. Health status of Food Handlers. Cross- contamination and its prevention methods. Introduction to HACCP principles and their application. Concept of TQM, GMP and Risk Assessment.

Practical

Identification of microorganism, preparation of slides, preparation of media. Collection of water samples. Testing of water for: (i) Physical quality (ii) Bacteriological quality. Survey of hygienic and sanitary condition in food shops/food vendors/ canteens. Report writing.

Suggested Readings

- Adams, M.K. and Moss, M.O. 2000. Food Microbiology, New Delhi: Panima Corp.
- Longree, K.L. and Blaker, G.C. 1982. Sanitary Techniques in Food Service. New York: John Wiley and Sons.
- Park, K. 1997. Textbook of Preventive and Social Medicine. 1st edn. Jabalpur: Banarsidas Bhanot.
- Srivastava, A. 2013. Food Hygiene and Sanitation, Neha Publishers and Distributers.
- Yadav, S. 1997. Food Hazards and Food Hygiene. 1stedn. Annual Publication Ltd., New Delhi.
- Willliam, C., Frazierad Dennie and Westheff, C. 1996. Food Microbiology, 4th edn. Tata McGraw Hill Company Limited.

Semester VII

S. No.	Course Title	Credit Hours
1.	Ethics in Human Research	1(1+0)
2.	Seminar	1(0+1)
3.	Elective courses (totaling credit hours of 18)*	18
	Total	**20**

Semester VIII

S. No.	Course Title	Credit Hours
1	Student READY	
	Option A (Any Two)	10 (0+10)
	IV. In plant Training (10 weeks) *	10 (0+10)
	V. Student Project**	10 (0+10)
	VI. Hands on Training	
	Option B	20 (0+20)
	Internship***	
	TOTAL	**20**

*Internship/ In plant training / attachment with Industry/ Research Institute (May be conducted in split manner in more than one industry/ institution/ organization)

** The student project will be R and D based, field study based or entrepreneurship based (incubation/ experiential learning)

*** The internship can be taken in service Industry (e.g. Hospital or Hotel) OR in Production Industry (e.g. Food/ nutraceuticals Industry) OR in Food Quality and Analysis Laboratories

1. Internship Options in 7th and 8th semesters

A. In-plant in hospitals

Understanding role of dietitian – role, concept, the recipients, duties, work schedule, Licenses, Certifications, and Registrations. Preparation of SOAP notes based on case studies and group discussion. Planning component. Preparation of list of parenteral and enteral products. Diabetic diet counselling- organizing exhibition in for the benefit of public- food exchange list and software used in diabetic diet counselling. Cardiovascular diseases- planning and presentation of different

types of diet for disease conditions. Practicing diet counselling for CV patients. Preparation of diet chart for different types of liver diseases, collection of case history of patient suffering from hepatitis, cirrhosis of liver and alcoholics. Kidney diseases- preparation of facts list handout and development of counselling tips- dietary counselling in a specialty hospital and diet exhibition for kidney disorder. Diet for gastro intestinal disorders- preparation of handouts- ulcer, high fiber, low residue- counselling- diarrhea, constipation, colitis, diverticulosis and ulcer. Preparation of overweight and underweight fact list handout and development of counselling guidelines, workshop for patients, Weight loss counselling– use of role play technique and workshop for patients at obesity clinic and fitness centers. Diet for pre- and post-surgery, burns. Preparation of cancer facts list handout. Home care for critically ill and requiring long term nutrition support. Planning normal and therapeutic diets – diabetes, cardiovascular diseases, liver diseases, kidney diseases, gastrointestinal disorders. Role play exercises for counselling. Supervised counselling of patients/clients.

B. In-plant in testing labs

Role of regional testing laboratories - methods of sample collection- handling and storage of samples, physical, chemical and microbiological. FSSAI - Role of Food Safety officer, method of inspection, processing of license, conducting awareness camps for stakeholders. Analysis of energy, protein, fat, vitamin, mineral and antioxidants in food groups. Attachment with food testing laboratories.

C. In-plant in food processing units

Attachment with – primary processing cereal, pasta making, flaking and puffing, cereal based convenience foods manufacturing, primary pulse processing, RTE / RTU foods manufacturing, fruit beverage manufacturing, Canning, pickling, preserve/ candy/ jam manufacturing, banana processing, milk processing, oil manufacturing, bakery and confectionary units.

ELECTIVE COURSES

Course Number	Course	Credit Hours
Elective-1 Nutrition and Dietetics		
1.	Diet Therapy for Hospitalized Cases	4 (1+3)
2.	E-applications for Dietetics	4 (1+3)
3.	Nutrigenomics	2 (2+0)
4.	Nutrition for Special Conditions	3 (2+1)
5.	Nutrition through life cycle	3 (2+1)
6.	Fundamentals of research methodology and library search	2 (1+1)
7.	Sports Nutrition	3 (2+1)
8.	Diet and Immunity	3 (2+1)
9.	Global Nutrition	2 (2+0)

Course Number	Course	Credit Hours
Elective-2 Food Science		
1.	Food processing and packaging	4 (3+1)
2.	Fruits and Vegetables Processing and Technology	4 (2+2)
3.	Food Safety and Packaging	2 (1+1)
4.	Food Toxicology and Quality Testing	3 (2+1)
5.	Food Chemistry	3 (3+0)
6.	Meat Processing and Technology	3 (2+1)
7.	Pulses and oilseeds: Processing and Technology	3 (2+1)
8.	Sensory Evaluation of Foods	2 (1+1)
Elective-3 Institutional Food Service Management		
1.	Institutional Food Service Management	3 (0+3)
2.	Sensory Evaluation of Foods	2 (1+1)
3.	Event Management	3 (0+3)
4.	Food processing and packaging	4 (3+1)
5.	Ergonomics in Food Service	2 (2+0)
6.	Food Standards and Quality Control	3 (2+1)
7.	Food Toxicology and Quality Testing	3 (2+1)
8.	Print and Electronic Journalism	3 (0+3)
9.	Tourism and Hospitality Management	3 (1+2)

*The institutions may formulate additional Elective courses as per specific local needs and facilities/ expertise available.

Students of other disciplines may choose any elective courses from the list of following minor courses in Food Nutrition and Dietetics.

Course Number	Course	Credit Hours
Elective-1 Nutrition and Dietetics		
1.	Diet Therapy for Hospitalized Cases	4 (1+3)
2.	E-applications for Dietetics	4 (1+3)
3.	Nutrigenomics	2 (2+0)
4.	Nutrition for Special Conditions	3 (2+1)
5.	Nutrition through life cycle	3 (2+1)
6.	Fundamentals of research methodology and library search	2 (1+1)
7.	Sports Nutrition	3 (2+1)
8.	Diet and Immunity	3 (2+1)

Elective-2 **Food Science**		
1.	Fundamentals of Food Science	2 (1+1)
2.	Principles of Human Nutrition	4 (4+0)
3.	Food processing and packaging	4 (3+1)
4.	Food Preservation and Storage	2 (0+2)
5.	Fruits and Vegetables Processing and Technology	4 (2+2)
6.	Meat Processing and Technology	3 (2+1)
7.	Pulses and oilseeds: Processing and Technology	3 (2+1)
8.	Sensory Evaluation of Foods	2 (1+1)
Elective-3 **Institutional Food Service Management**		
1.	Food Psychology	2 (2+0)
2.	Fundamentals of Food Science	2 (1+1)
3.	Principles of Human Nutrition	4 (4+0)
4.	Normal Nutrition and Meal Planning	3 (2+1)
5.	Food Standards and Quality Control	2 (1+1)
6.	Sensory Evaluation of Foods	2 (1+1)
7.	Event Management	3 (0+3)
8.	Ergonomics in Food Service	2 (2+0)
9.	Food processing and packaging	4 (3+1)
10.	Print and Electronic Journalism	3 (0+3)

ELECTIVE COURSES

Students of other disciplines may choose any elective courses from the list of following minor courses in Food Nutrition and Dietetics.

S. No.	Course	Credit Hours
Elective-1 Nutrition and Dietetics		
1	Diet Therapy for Hospitalized Cases	4 (1+3)
2	E-applications for Dietetics	4 (1+3)
3	Nutrigenomics	2 (2+0)
4	Nutrition for Special Conditions	3 (2+1)
5	Nutrition through life cycle	3 (2+1)
6	Fundamentals of research methodology and library search	2 (1+1)
7	Sports Nutrition	3 (2+1)
8	Diet and Immunity	3 (2+1)
9	Global Nutrition	2 (2+0)

Diet Therapy for Hospitalized Cases 4 (1+3)

Objectives

1. To learn about specialized dietary regimes or meal plans
2. Nutritional requirement of hospitalized cases
3. Learning to apply of principles of therapeutic nutrition in hospital settings

Theory

Enteral and parenteral feeding, feed formulation, diseases antagonism and synergism, use of nutraceuticals and supplements for hospital cases, diet for bariatric surgery. Reading prescription, interaction with drug, taking diet and medical history, duration hospitalization in following conditions: GIT disorders, surgery (liver, kidney, CVD), cancer, ICU patients, burns, injury, sepsis, trauma, pre- and post-operative conditions, hospitalization due to diabetes, malnourished neonates, premature infants, multiple organ problems. Neoplastic diseases – goals of nutritional care for cancer patients.

Practical

Planning and preparation of a clear fluid, full fluid diet, soft diets and tube feeding formula for prep and post-operative patients. Diet plan and nutrient calculation for peptic ulcer, dysentery, diarrhea and constipation. Preparation of SOAP for liver disorders. Diet plan and nutrient calculation for fatty liver, hepatitis cirrhosis, cholecystitis and cholelithiasis of liver. Preparation of SOAP for obesity. Diet planning for obese patients and bariatric patients Preparation of SOAP for underweight and diet planning. Preparation of SOAP for diabetes mellitus and dietary modification. Formulation of carbohydrate, protein, fat, fiber and sodium exchange list. Preparation of SOAP for Cardiovascular diseases. Diet planning for atherosclerotic, and congestive heart failure. Preparation of SOAP for hyper tension and diet planning. Preparation of SOAP for kidney diseases. Diet planning for glomerulonephritis, nephrotic syndrome, nephrosclerosis syndrome, renal calculi, dialysis and renal failure, AIDS, tuberculosis and burns. Preparation of SOAP for allergy and diet planning. Diet planning for inborn errors of metabolism. Diet planning for cancer patient. Diet planning for protein energy malnutrition.

Suggested reading

- Eastwood, M. 2000. Principles of Human Nutrition, Chapman and Hall, London.
- Mahan, L.K. and Escott-Stump, S. 2000. Krause's Food, Nutrition and Diet Therapy. W.B. Sanders Company. Philadelphia.
- Peckenpaugh, N.J and Poleman, C.M. 1999. Nutrition Essentials and Diet Therapy. W.B. Saunders Company, Philadelphia.
- Raghuvanshi, R.S. and Mittal, M. 2014. Food Nutrition and Diet therapy. Westvill Publication New Delhi.
- Suitor, C.W. and Crowley, M.F. 2000. Nutrition-Principles and Application in Health promotion. J.B. Lippin cott, Company. Philadelphia.
- Towsend, C.E and Roth, R.A. 2000. Nutrition and Diet Therapy. Delmar Publishers. New York.
- www.cellinteractive.com

- www.nutrition.org.uk
- www.fnic.nal.usda.gov

E-applications for Dietetics **4 (1+3)**

Objectives

1. Introducing the concept AI among students
2. Understanding the role of nutrition applications as the means for automatic dietary intake and energy expenditure measurements

Theory

Basic principles in developing a e-applications, Planning process, rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept. Audience requirement. audience requirement, Idea creation – Sketching – Wireframing - Graphic designing - Coding and programming, Importance of e-applications in Dietetics- role of AI. Diet and nutrition tracking App – Calorie calculating app – app for calculating energy expenditure – app for calculating energy requirement – Stages of developing nutri App for dieting. Six types of technology assisted instruments for dietary assessment -: interactive computer-based technologies - Personal Digital Assistants (PDAs) - web-based technologies - mobile devices, specialized cameras and tape recorders- scan and sensor technologies. Integration of e- Dietary Assessment tools into the care process. Food atlas -artificial intelligence in dieting. Advantages and disadvantages of e-dietary assessment methods. e-courses on nutrition and available platforms.

Practical

Apps listing- Commercially available AI Based food and nutrient assessment system- Nutrition facts, CRON-O-METER, Diet organizer, e-fit, Easy menu balanced meal planner, food file, Nutrition info. Software for nutrient intake calculation and Dietary assessment software, e-portals of NIN such as Count What you Eat, ICMR-NIN TATA Dashboard center, NUTRIFY INDIA NOW, Tracking commercial apps and developing inventory of available apps related to health and nutrition tracking. Diet history- Google forms, photography method, electronic household weighing, sensor based health assessment for apps for tracking and measuring BP, blood sugar, hemoglobin, smart watches, fitness tracker, Online survey design for nutritional and dietary assessment for understanding current trends in dietary intake in particular group. Developing messages for public masses. Developing web page/blog/e-course. Info. graphic designing/posters/pamphlets. Attending training and workshops related to e-application/AI/coding or programming. Generating awareness using e-application. Organizing awareness camps among general public on use of nutrition related online platforms and application for tracking their dietary intake. Application based assignment- nutrient analysis/estimation, data collection – 24-h recall, diet history, food record, menu planning, nutrition counselling, food portion size estimation, standardized recipe formulation. Project to be submitted by student using any e-tool.

Suggested reading

- Côté, M., and Lamarche, B. 2021. Artificial intelligence in nutrition research: perspectives on current and future applications. *Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme*, 1–8. Advance online publication. https://doi.org/10.1139/apnm-2021-0448

- Count What You Eat. NIN http://count-what-you- eat.ninindia.org:8080/CountWhatYouEat/Receipes.do
- Emma Tonkin, Julie Brimblecombe, Thomas Philip Wycherley. 2017. Characteristics of Smartphone Applications for Nutrition Improvement in Community Settings: A Scoping Review, *Advances in Nutrition*, Volume 8, Issue 2, March 2017, Pages 308–322, https://doi.org/10.3945/an.116.013748
- Tom Taulli. 2019. Artificial Intelligence Basics: A Non-Technical Introduction apress.
- Wendy Willard. 2010. Web Design: A Beginner's Guide. Second Edition. McGraw-Hill Education.

Nutrigenomics **2 (2+0)**

Objective

To understand, in depth, the influence of genetics on micronutrient metabolism, and implications for human diseases including inherited inborn disease, metabolic disease, cancer, neurodevelopment, and neurodegenerative diseases, etc.

Theory

Introduction - role of nutrition in preventing risk of disorders – proposed strategies for management of nutrient disorders – personalized medicine – personalized nutrition; Introduction to genomics and its importance in health care, agriculture and environment – Introduction to Nutrigenomics Definition - role of Personalized nutrition in human diseases. Genes – structure – biochemical and molecular nature of genes; Central Dogma of Life; - regulation of gene expression –Role of diet/nutrition in regulation of gene expression – metabolic programming - Genetic basis of Dietary responses - Diet Vs Gene interactions. Genetic susceptibility to diets. Introduction to methods of developing nutritious foods/diet – intervention of biotechnology/genomics in producing nutritionally important molecules/compounds – production of therapeutic/medicinal proteins/hormones/molecules through genetic engineering –Biotech processes in value addition of dietary foods - fermentation process, and genetic improvement of food grade microorganisms; crop varieties with enhanced nutrition. Introduction to transcriptomics, proteomics, metabolomics; applications in nutrition research - Metabolic Syndrome in humans - Nucleotide polymorphisms associated with common/major dietary disorders - inborn errors of metabolism – lactose intolerance, gluten enteropathy and phenylketonuria. Biomarkers – importance, discovery and validation-screening for bioactive nutrients and compounds - Cell line testing – zebrafish model and animal model - Scientific, technological and resource constraints on genomics - important factors affecting development in nutrigenomics.

Suggested readings:

- Carlsberg, C., Ulven, M. S. and Molnar, F. 2016. Nutrigenomics. Springer Pub.
- Lynnette, Ferguson R. 2013. Nutrigenomics and Nutrigenetics in Functional Foods and Personalised Nutrition. CRC Press.
- Nestle M. 2003. Safe Food: Bacteria, Biotechnology and Bioterrorism. Univ. of California Press.
- Rogers PL and Fleet GH. 19

- Journal of the American Dietetic Association,
- https://scholar.google.co.in/scholar?q= (search).
- http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3602567/pdf/13197_2012_Article_775.pd.

Nutrition for Special Conditions **3 (2+1)**

Objectives

1. To gain basic knowledge on changes occurring in the physiology and metabolism of human body as a result of change in extreme environment
2. To know the nutrition in emergency, nutrition and health problems, food distribution strategies and dietary management
3. To acquire basic knowledge about immune nutrition in acute and chronic inflammation

Theory

Nutritional requirements for extreme environments: Introduction - General adaptive mechanisms to environmental extremes and role of nutrition in successful acclimatization – decreased oxygen availability at high altitude – nutrition requirements for high altitude – Nutrition requirements in cold and polar environment- thermoregulation in cold –dietary guidelines for cold conditions. Nutrition requirements in hot environments- effect of heat stress – energy expenditure in hot environment. Nutrition on requirements for astronauts (space missions); Sea and air travel nutrition**:** introduction, need and scope for space travel, history of space travel; -changes in body composition during space expedition and nutrition requirements. Physiological changes in human body, psychological preparedness, health and nutritional problems, nutrient requirements and dietary management during sea and air travel. Nutrition in Emergencies: need and importance, types of emergency situations such as natural and manmade, nutritional and health problems in emergencies. Control of communicable diseases through sanitation and immunization- Food distribution strategies- nutrient requirement and dietary management during emergencies. Nutritional requirements during starvation: total starvation – biochemistry of starvation, conditions developing starvation, features of starved body – survival period, effects of starvation/human body adaptation, metabolic alterations and nutrition requirements during starvation. Immuno-nutrition: nutrients affecting the immune system at the physiological, cellular and genetic level. Nutrients involved in the inflammatory response, role of specific nutrients in immune suppression and in immune promotion. Acute inflammation- features, causes, vascular and cellular events, inflammatory cells and mediators. Chronic inflammation- causes, types, classification non-specific and granulomatous with examples, repair, and wound healing by primary and secondary union, factors promoting and delaying the process. Healing in specific site including bone healing.

Practical

Studying the existing ration scale for army personnel in plains/high altitudes, space foods/ emergency ration foods, planning and preparation of diet for army person in the high altitudes, hot environment and cold environment, Planning and preparation of diet for space mission, preparation of snacks foods for space , fibre rich foods ,ergogenic foods / bars for high altitude, ready to eat appetizers - juices/candy, high energy foods for starvation, RTE/ RTC foods for emergencies,

high protein foods, planning and preparation of diet for acute and chronic inflammation condition – Rheumatic arthritis/Asthma, Planning and preparation of diet for immunity

Suggested Readings

1. Aggarwal, Bharat B. and Heber, David (2014) Immuno-nutrition: Interactions of Diet, Genetics, and Inflammation, CRC Press.
2. Corinne, H.R, Marilyn, R. L., L. C. Wanda and Garwick, E. (1982). Normal and therapeutic nutrition. (Pp- 1-16). New York, Macmillan Publishing Company.
3. Kathleen, M. L. and Raymond, J. L. (2016) Krause's Food and the Nutrition Care Process. 14th Edition, Saunders, Philadelphia.
4. Moris, E. S. (1994) Modern nutrition in health and disease. Leaned Febinger, USA
5. Sehgal, S. and Raghuvanshi, R. S. (2007) Textbook of community nutrition Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
6. WHO (1997) Applied health research priorities in complex emergencies, Geneva
7. https://www.cdc.gov/ncbddd/adhd/index.html.
8. https://www.unhcr.org/45fa745b2.pdf.
9. http://apps.who.int/disasters/repo/13849_files/i/nutrition_in_emergencies_ppt.pdf.
10. https://www.unicef.org/media.
11. https://www.nasa.gov/sites/default/files/space_nutrition_book.pdf.
12. http://spacelink.nasa.gov/products.

Nutrition through life cycle 3 (2+1)

Objectives

1. To cover nutritional needs of individuals during critical stages of development
2. To learn about the biological basis for nutritional requirements in normal development and maintaining health in adulthood
3. To learn about consequences of over- and under-nutrition and how to identify and address these issues will be discussed

Theory

Infancy- Role of nutrition on physical and mental development, rate of growth-weight as an indicator, assessment of growth, nutrient requirement during infancy, feeding of infants, value of breast feeding on infants, breast feeding versus artificial feeding, types of milk and their use in infant feeding. Weaning and supplementary foods, weaning practices in community, feeding of premature and low-birth-weight infants. Nutritional disorders and common ailments in infancy, feeding the sick child, immunization schedule and growth charts Preschool age: Physical growth and mental development, prevalence of malnutrition in preschool years and food habits, nutritional requirements during preschool age and supplementary foods School age. Physical growth and mental development, nutritional requirements during school age, specific problems, specific problems in feeding school children Adolescence. Physical and physiological changes, nutritional requirements,

food preferences and nutritional problems, problems, growth spurt and nutrition, adolescent fads influencing nutrition. Adulthood, Sex, occupation and income, nutritional requirements, biological and nutritional consequences and complications due to pollutants, vegetarianism. Nutrition, wok capacity and physical fitness. Nutrition, infection and immunity, nutrients and drugs interaction. Pregnancy. Eating disorders, Preconception nutrition. Nutritional related problems during pregnancy and lactation. Physiological changes in pregnancy, weight gain during pregnancy, food and nutrient requirements. Complications of pregnancy and their nutritional management, impact of nutrition on the outcome of pregnancy. Nutritional need of fetus during different stages of fetal cell growth and maternal nutritional needs. Psycho-physiology of lactation; milk synthesis and secretion, maternal needs during lactation, composition of colostrum and mature human milk, milk of mothers of pre-term babies. Non- nutritional factors of human milk; immunological factors, enzymes, hormones. Human milk banking. Elderly. Physical and physiological changes, nutritional requirements, problems of old age, nutrients influencing aging process

Practical

Grouping of foods based on richness of nutrients and quantifying foods to give uniform content of each nutrient. Planning and formulation of food exchange lists. Planning, preparation and evaluation of diet for adult men and women involved in different activities. Planning, preparation and evaluation of diets for pregnant women, , lactating mothers, weaning and supplementary foods for infants, preschool children, school going children, packed lunches for preschoolers and school children, adolescent boys and girls, elderly, preschool children with PEM and vitamin. A deficiency Planning diets for anemic children, adolescents and pregnant women.

Suggested Readings

1. Corinne H.R, Marilyn R. L, Wanda L. C and E. Garwick. (1982). Normal and therapeutic nutrition. (pp- 1-16). New York, Macmillan Publishing Company.
2. Moris, E.S. (1994). Modern nutrition in health and disease. Leaned Febinger, USA
3. Srilakshmi, B. (1995). Dietetics. Newage international publishers, New Delhi.
4. Williams, S.R., Worthington, R.S., Sneholinka, E.D., Pipes, P., Ress, J.M. and Mahal, K.L. (1988). Introduction to nutrition throughout the life cycle. Times Mirroe/Mosby College Publishers.

Fundamentals of research methodology and library search 2 (1+1)

Objectives

1. Understand some basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Select and define appropriate research problem and parameters
4. Prepare a project proposal (to undertake a project)
5. Organize and conduct research (advanced project) in a more appropriate manner
6. Write a research report and thesis
7. Write a research proposal (grants)

Theory

Introduction to Research - Research: Meaning, Types, Scope and Significance, Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process. Guiding Principles in Selection of Research Problem; Research Objectives and Approaches, Problem Identification and Formulation, Research Question – Investigation Question Measurement Issues - Hypothesis - Qualities of a good Hypothesis, Null Hypothesis and Alternative Hypothesis. Hypothesis Testing - Logic and Importance. Research Process and Criteria of Good Research; Research Method ; Research Design – Meaning, Need, Key Components, Data Collection, Survey and Sampling, Data: Meaning, Nature, Types and Sources; Methods of Collecting Secondary Data, Surveys – Definition, Purpose and Scope; Survey Techniques and their Limitations., Questionnaires and Schedules – Definition and Differentiation; Types of Questionnaires; Salient Features of an Effective Questionnaire, Sampling and Sample Designs: Concept, Purpose and Types; Criteria for Selecting appropriate sampling Procedure; Data Analysis – Tools and Techniques, Use of proper statistical procedures, Preparation of Research Report, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

Practical

Identifying problem, formulating research hypothesis, questionnaire design, collection of secondary data, analysis and report writing. Use of reference management software, article writing.

Sports Nutrition 3 (2+1)

Objectives

1. To develop an understanding about the concept of diet planning for exercise and sports
2. To gain knowledge of nutritional requirements for sports persons and making diet plans
3. To understand the current theories on the relationships between diet and performance in sports, exercise, and health

Theory

Physical fitness – principles, types, components and its assessment. Introduction, Nutritional considerations for sports / exercising person as compared to normal active person. Energy substrate for activities of different intensity and duration, aerobic and anaerobic activities. Fluid balance in sports and exercise, importance, symptoms and prevention of dehydration, Sports drink, Energy enhancers and other commercial sports food products. Macro Nutrients-Carbohydrate as an energy source for sport and exercise, Carbohydrate stores, Fuel for aerobic and anaerobic metabolism, Glycogen re- synthesis, CHO Loading, CHO composition for pre exercise, during and recovery period. Role of fat as an energy source for sports and exercise. Fat stores, regulation of fat metabolism, factors affecting fat oxidation (intensity, duration, training status, CHO feeding), effect of fasting and fat ingestion. Protein and amino acid requirements, Factors affecting Protein turnover, Protein requirement and metabolism during endurance exercise, resistance exercise and recovery process. Important micronutrients for exercise- B complex vitamin and specific minerals. Exercise

induced oxidative stress and role of antioxidants. Chronic dieting and eating disorder. Female athletic triad, sports anaemia Dietary supplements and ergogenic aids (nutritional, pharmacological and physiological). Use of Nutritional supplements in strength/power sports and team sports- use, effects, efficacy and safety – Creatine monohydrate, Sodium bicarbonates, Nitrates – B-Alanine, Caffiene – Protein supplements – Fat burners.

Suggested Readings

1. Banardot, Dan. (2000). Nutrition for Serious Athletes. Human Kinetics
2. Driskell, Judy A. and Wolinsky, Ira (Eds). 2000. Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition. CRC Press
3. Jeukendrup, A., and Gleeson, M. (2010). Sport nutrition: an introduction to energy production and performance. 2nd edn. Human Kinetics.
4. McArdle, W. D., Katch, F. I., and Katch, V. L. (2009). Sports and exercise nutrition. Lippincott Williams and Wilkins.
5. Satyanarayan, K, Nageshwar Rao. C., Narsinga Rao, B. S., Malhotra, M. S. (1985). Recommended Dietary Intakes for Indian Sportsman and Women., Hyderabad, National Institute of Nutrition.

Diet and Immunity 3 (2+1)

Objectives

1. To gain a comprehensive understanding of the immune system and its role in protecting the body from disease
2. To explore the impact of various nutrients on immune function
3. To understand the potential benefits of specific foods for immune health

Theory

Introduction to Immune System: Cells, Organs, and Functions, Innate and Adaptive Immunity Immunodeficiency and evaluation of Immune function. Alcohol and Immune function, Auto-antibodies, NCDs and Autoimmunity. The Importance of Gut Microbiome for Immune Health, Nutrient-Immune Interactions Essential Vitamins and Minerals for Immune Function, Role of Antioxidants in Immune Response, Impact of Macronutrients) on Immunity, Indian Diet and Immune System Benefits, Herbs, Medicinal plants and other Plant-Based Diets for immunity enhancement. , Role of Hydration in Immune Function, Understanding the Role of Dietary Fats and Immune Function, Intolerances and Immune System Response, Immunity Booster Foods, Diets and Autoimmune Conditions, Technology and apps in promoting healthy eating habits for immune support.

Practical

Exploring local herbs and medicinal plants as immunity booster. Study of different pathogenic organism and their interaction with food compounds. Planning of individualized diet plan for different auto immune diseases. Planning of individualized diet plan for different conditions of food intolerances.

Suggested Readings:

- Bhaumik, D., and Chattopadhyay, S. (2012). Immunity and Ayurvedic Nutrition. Springer India.
- Chopra, A., and Singh, V. (2017). Ayurveda for Life. Penguin Random House India Private Limited. Indian Council of Medical Research. (2010). Dietary Guidelines for Indians - A Manual. National Institute of Nutrition (India).
- Gershwin M E, Nestel P and Keen CL. (2004) Handbook of Nutrition and Immunity. Humana Press, Totowa, New Jersey.
- Sharma, H. L. (2014). Cooking with Ayurveda. Penguin Random House India Private Limited.
- National Institute of Nutrition (India). https://www.nin.res.in/
- Indian Dietetic Association. https://idaindia.com/

Global Nutrition 2 (2+0)

Objectives

1. To analyze the global burden of malnutrition and its various forms (undernutrition, overnutrition, micronutrient deficiencies)
2. To explore the ethical considerations in global food systems, including food justice, sustainable practices, and corporate accountability
3. To examine the role of technology and innovation in addressing global nutrition challenges
4. To understand the effectiveness of international nutrition programs and initiatives

Theory

Defining Global Nutrition: Scope and Challenges, Nutritional Transition, Global Trends and Regional Differences in Food Systems and Nutrition, Sustainable Agriculture and Food Production Practices, Micronutrient Deficiencies, Nutritional Epidemiology, Food Traditions and Dietary Practices in Different Regions, Food Waste and Loss: Global Challenges and Solutions, Ethics of Industrial Food Production and Food Justice Issues, Global Nutrition Programs and Policies, National Governments and International Collaboration, Issues and Trends in Global Food and Nutrition Security.

Suggested Readings:

1. Albert, J. L. (Ed.) 2000. Food, nutrition and agriculture. FAO Publication.
2. Branca, F., Lardeux, M. and Leroy, J. 2007. Food security, food safety and the right to adequate food. Agriculture and Human Values, 24(3), 285-294.
3. Fanzo, J., Hawkes, C. and Berry, E. M. 2013. Global food security and the right to food. Public Health Reviews, 35(1), 22-31.
4. Home - Global Nutrition Report

S. No.	Course	Credit Hours
Elective-2 Food Science		
1	Food processing and packaging	4 (3+1)
2	Fruits and Vegetables Processing and Technology	4 (2+2)
3	Food Safety and Packaging	2 (1+1)
4	Food Toxicology and Quality Testing	3 (2+1)
5	Food Chemistry	3 (3+0)
6	Meat Processing and Technology	3 (2+1)
7	Pulses and oilseeds: Processing and Technology	3 (2+1)
8	Sensory Evaluation of Foods	2 (1+1)

Food processing and packaging 4 (3+1)

Objectives

1. To impart knowledge of various areas related to food processing and packaging
2. To enable the students to understand food composition and its physic chemical, nutritional, microbiological and sensory aspects

Theory

Food processing and preservation techniques for cereals, milk, fruits and vegetables, oil seeds, meat, fish and poultry and their impact on physical and chemical characteristics. Physico-chemical characteristics, nutritional quality and shelf-life studies. Factors effecting quality of processed foods. Food packaging, package functions, requirement and packaging materials. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs.

Practical

Market survey for packaged processed food stuffs. Cereal cookery. Preparations showing dextrinization and gelatinization, gluten formation and influence factors. Vegetable cookery: effect of heat and alkali on pigment, preparation of soups, salads and beverages. Use of milk and milk products and egg in various preparations Estimation of shelf- life of packaged food stuffs.

Suggested Readings

1. Frank, A. and Paine, H.Y. (2003). A Handbook of food packaging. Springer science and business Media, U.K.
2. Kalia, M. and Sood, S. (2010). Food preservation and processing. Revised edition, Kalyani Publishers, New Delhi.
3. Potter, N. N. (1996). Food science. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Srilakshmi, B. (2010). Food science. 5th edn) New Age International Pvt. Limited Pub., New Delhi.

Fruits and Vegetables Processing and Technology 4 (2+2)

Objectives

1. To acquire a basic knowledge of in the field of fruit and vegetable processing
2. To acquire a basic understanding of agriculture sector and processing of fruits and vegetables is of vital importance
3. To develop an essential understanding of the scope of fruit and vegetable processing in the country
4. To acquire a fundamental background of the methods of fruit and vegetable processing.
5. To practice the methods and techniques of fruit and vegetable processing at laboratory scale, and to evaluate the student`s produce in each lab

Theory

Importance and scope of fruits and vegetables in human diet. Scenario of fruit and vegetable production and processing at national and international level. General principles involved in preservation of fruits and vegetable products. Tools, equipment, lay out and other requirements of fruit and vegetable processing unit. Processing using sugar - principles and processing of jam, jelly, marmalade, fruit bar, preserves and candies. Unfermented and fermented products - fruit juices, RTS, nectar, cordial, squash, syrup, carbonated beverages, cider and vinegar. Processing using salt - principle – brining. Preservation of horticultural produces - preparation of pickles, ketchup and sauces. Tea, coffee and cocoa products Wine and fermentation technology. Drying and dehydration: definition, principle, method, suitability - types of driers - solar, cabinet, spray drier, drum drier, fluidized bed drier and freeze drying. Methods of concentration - open kettle, flash evaporators, thin film evaporators, vacuum evaporators, freeze concentration, dehydro- freezing, ultrafiltration and reverse osmosis. Processing of dehydrated fruits, vegetables and spice products and fruit pulp. Canning - principles, methods - preparation of canned products - spoilage of canned foods and its prevention. Preservation by low temperature: definition, principle, method, suitability - refrigeration, freezing, preparation of frozen foods. Preservation by controlled atmosphere, modified atmosphere - definition, principle, method, suitability. Processing by irradiation - definition, principle, method, suitability and application of irradiation in food industry.

Practical

Evaluation of pectin grade; Canning of mango/guava/papaya; Preparation and quality evaluation of fruit jam with fruits of regional importance; Preparation and quality evaluation of fruit jelly with fruits of regional importance ;Preparation and quality evaluation of fruit marmalade; Preparation and quality evaluation of fruit preserve and candy; Preparation and quality evaluation of fruit RTS; Preparation and quality evaluation of squash / syrup; Preparation of grape raisin / dried fig / dried banana; Processing of tomato products; Preparation and evaluation of dehydrated vegetables; Preparation and quality evaluation of wafers with vegetables / tubers; Preparation of fruit cheese; Preparation of pickle / mixed pickle; Preparation of dried ginger / mango powder (amchur).

Suggested reading

- Giridharilal, Sidappa.G. S and Tandon, G.L.1979. Preservation of Fruits and Vegetables. ICAR. New Delhi.

- GOI. 2018. Horticulture at a glance. Government of India Ministry of Agriculture and Farmers' Welfare Department of Agriculture, Cooperation and Farmers' Welfare Horticulture Statistics Division.
- Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised edition, Kalyani Publishers, New Delhi.
- Singh, I. S. 2009. Post-harvest handelling and processing of fruits and vegetables. Westville Publishing House, New Delhi.
- Sudheer, K.P and Indira, V. 2007. Post-Harvest Technology of Horticultural Crops. New India Publishing Agency, PitamPura, New Delhi-110088.
- Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. 1 and 2. Indus Publishing Company. New Delhi.
- www.cfs.purdue.edu/class.
- https://agritech.tnau.ac.in/postharvest/pht_intro.html.

Food Safety and Packaging 2 (1+1)

Objective

- To provide students with an insight into advanced packaging (technical and business) topics with a food safety focus

Theory

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors. General principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Food safety and standard regulations national and international standards. Food safety, safety hazards and risks, food related hazards, microbiological considerations in food safety, effect of processing and storage on microbial safety, microbiological methodology, HACCP as a method to prevent food borne illness, chemical hazards associated with foods. Types of Packaging systems, special solutions and packaging machines. Different types of packaging materials, their key properties and applications, Metal cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging. Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper plastic film and laminates aluminum foil glass containers (visual defects, color, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

Practical

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for

glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapors transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

Suggested reading

- Adams, M.K. and Moss, M.O. 200. Food Microbiology, New Delhi: Panima Crop.
- Coles, R., McDowell, D., Kirwan, M.J. 2003. Food Packaging Technology. Blackwell Publishing Co.
- Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication
- John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House,
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Longree K.L. and Blaker G.C. 1982. Sanitary Techniques in Food Service. New York: John Wiley and Sons.
- Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill
- Manay, N.S. and Shadaksharswamy, M. (2001). Food facts and principles, II Ed. New Age International (P)Ltd. Publishers, New Delhi.
- Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
- Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.
- Roday, S. 2011. Food Hygiene and Sanitation with Case Studies. Tata McGraw-Hill Education. 425p.

Food Toxicology and Quality Testing 3 (2+1)

Objectives

1. To give introduction to possible toxic effects of food additives and naturally occurring environmental toxins in food
2. To be able to define toxicology
3. To be able to define the most important contaminants in food, the toxicology of various additives and environmental toxins, as well as their sources
4. To explain food safety, the substances that are of relevance for food safety
5. To be able to explain what risk analysis, assessment and management in relation to food safety is, and know which organizations are involved in this type of work nationally and internationally

Theory

Food toxicology – definition, introduction and significance. Classification of toxic constituents. Food poisoning –types, causative factors, signs and symptoms, preventive measures. Natural food

toxins – pulses, oil seeds, sea foods, processed animal foods. Anti-nutritional factors, other food toxins, their harmful effects and methods of removal. General characteristics, occurrence, properties and inactivation of protease inhibitors, trypsin inhibitors, haemagglutinins, goitrogens, gossypol. General characteristics, occurrence, properties and inactivation of saponins, lathyrogens, avidin and other antimetabolites. Microbial toxins – classification, source of contamination, effect on health, preventive measures, methods of inactivation / destruction. General characteristics, occurrence and properties of mycotoxins, aflatoxin, ochratoxin and patulin. Methods to detect and prevention of mycotoxins. Chemical toxins – Pesticides - Pesticide and insecticide residual toxicity – sources and health hazards, insecticides, metallic and others. Mineral toxicity – Chlorine and Fluorine, Heavy metals toxicity – Lead and Chromium, Mercury, Arsenic and Iron, residual effects, preventive measures, methods of removal. Food additives – classification, toxicity and effects. Toxins developed during processing. Food packaging material – Potential contaminants from food packaging material. Detection of toxins in food chain.

Practical

Methods of detect aflatoxin and gossypol**.** Methods of detect trypsin inhibitors and protease inhibitors. Use of AAS for detection of lead, chromium, mercury, arsenic, iron, detection of tannin and phytic acid. Visit to toxicology lab and public health laboratory. Visit to Quality Testing Laboratory, food processing industry/ government laboratory.

Suggested readings:

- Debasis Bagchi, Anand Swaroop. 2016. Food Toxicology, CRC Press.
- Derelanko, M.J. and Hollinger, M.A. 2002. Handbook of toxicology, 2nd edn, CRC Press.
- Gordon L. Robertson, 2006. Food Packaging Principles and Practice, 2nd edn, CRC press. London.
- Hodgson, Ernest. 2004. A Textbook of Modern Toxicology. John Wiley and Sons, IncI.
- Srinivasan Damodaran, Parkin, Kirk L., and Fennema, Owen R. 2007. Fennema's Food Chemistry, 4th edn. Taylor and Francis.
- Takayuki Shibamoto and F. Bjeldanes, Leonard. 2012. Introduction to Food Toxicology. Academic Press.
- Compendium_Food_Additives_Regulations_08_09_2020-compressed.pdf (fssai.gov.in)
- http://www.fda.gov/downloads/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathog ensNaturalToxins/BadBugBook/UCM297627.pdf
- http://www.fda.gov/
- www.standardsdata.in/
- www.fssai.gov.in
- http://www.foodqualitynews.com/
- http://www.cdc.gov/

Food Chemistry 3 (3+0)

Objectives

1. To provide an understanding of the chemical function and properties of major food components

2. To provide an understanding of the chemical interactions of food components and their effects on sensory and nutritional quality, functional properties, and safety of foods

Theory

Nature, scope and development of food chemistry. Properties of foods: Solubility, vapour pressure, boiling point, freezing point, osmotic pressure, viscosity, surface tension, specific gravity, oxidation and reduction. Acids, bases and buffers. Chemical bonding - Colloids - Water and moisture in foods- Hydrogen bonding, bound water, capillary water and loosely bound water; structure and properties of water molecule Water activity and effects on storage life. Carbohydrates- classification, structure and properties of carbohydrates and dietary fiber. Proteins in foods- classification, structure and properties of proteins and amino acids, Pure proteins of plant and animal origin - their functional characteristics, physical, chemical and nutritional changes in protein during processing. Chemical and enzymatic modification of protein. Lipids – introduction classification, physical and chemical characteristics. Chemistry of fats and oils– processing aspects Changes of lipids / fats during processing and storage. Role and use of lipids /fat, physiological effects of lipids - physiochemical aspects of fatty acids in natural foods, crystallization and intersification. Vitamins and minerals - Properties of Vitamins and minerals, enrichment, restorations, fortifications, Losses of vitamins and minerals. Structure and properties of chlorophyll, anthocyanin, flavonoid, tannin, betalin, quinone, carotenoid, myoglobin and hemoglobin. Pigments used in food industry. Flavor compounds - terpenoids, flavonoids, Sulphur compounds and volatile flavor compounds. Enzymes, enzyme inhibitors, enzymatic browning, enzymes in food processing. Composition of beverages- hot drinks, tea, coffee, cocoa, cold drinks, soft-drinks, fruit beverages and alcoholic drinks-beer, wine etc. Sugars and sweeteners, reaction of sugars, non-nutritive sweeteners. Food additives: Antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors, and flavor enhancers, humectants and anti-caking agents, leavening agents, nutrient supplements, preservatives, stabilizers, thickeners. Browning reactions in foods

Suggested readings:

- Chopra, H.K., Panesar, P.S. 2010. Food Chemistry, Narosa Publishing House, New Delhi, 2010.
- Khader, Vijaya. 2001. Textbook of Food Science and Technology, Indian Council of Agricultural Research, New Delhi.
- Manay, N.S. and Shadaksharswamy, M. 2001. Food facts and principles, II Ed. New Age International (P)Ltd. Publishers, New Delhi.
- Meyer, L.H. 2004. Food Chemistry, CBS publishers and distributors private limited, Chennai,
- Meyer L.H. 1991., Food Chemistry, AVI Publications, New York
- Potter, N.N. 1996. Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
- Walstre Pieter. 2001. Physical chemistry of foods, Marcel Dekker, Inc. New York.
- www.fssai.gov.in

Meat Processing and Technology 3 (2+1)

Objectives

1. To provide knowledge and skills for quality production of meat and meat products
2. Develop human resource for meat industry and associated activities

3. Train personnel for self-employment
4. Impart knowledge and technical proficiency in:
   (a) Good slaughter practices
   (b) Handling of meat on scientific lines
   (c) Production of quality meat and meat products
   (d) Testing and quality control of meat and meat products
   (e) Managing small and medium enterprises

Theory

Animal foods – needs – availability – demand and supply of animal foods. Growth and development of Indian meat industry. Meat and poultry - pre-slaughter operations - preparation of animals and poultry birds for slaughter. Slaughtering of animals – requirements -stunning methods. External treatment of carcasses - skinning, depilation – external and internal treatment of carcasses – evisceration - slaughter lines and systems. Identification of parts of the animal - structure – composition – nutritive value of meat. Post mortem changes of meat – eating quality of meat tissues. Equipment in processing of meat - their design – usage and its application. Meat cutting – types of carcasses - indicators of quality of carcass. Meat composition – quality and spoilage. Eating quality of meat – color - chemical nature of myoglobin - discoloration of meat - texture and tenderness of meat - pre-slaughter and post slaughter factors effecting tenderness – improvement of tenderness. Spoilage of meat - sources of contamination, growth of microorganisms – identification of spoilage. Meat inspection, sanitation and preservation techniques. Principles of preservation of meat -hurdle concept. Methods of preservation of meat - chilling and freezing – heating – canning and thermal processing - curing and smoking, dehydration - Intermediate moisture foods – freeze drying, irradiation, high pressure treatment. Ohmic heating, High power ultra sound processing technology. Direct microbial inhibition – antibiotics – chemical preservation. Processed meats - formulation of meat products- enrobed meat products– fermented, canned and restructured meat products

– restructured steaks, roasts, blocks – portion and sticks. Dried meat – pickled, spiced and marinated meat
– prefabricated meat- effect of processing on quality of meat products. Equipment's used in processing of meat. Poultry - dressing - composition - nutritive value - processing and preservation methods - storage, spoilage and preventive measures of poultry meat. Standards and quality control measures adopted for meat and meat products. National and International - HACCP for meat and poultry and processed meat products. Fraudulent substitution of meat - its recognition and impact. Waste utilization of animal foods - edible and non-edible parts. New concept in meat technology: cultured meat, lab-grown meat. Plant-based meat analogues, *in-vitro* meat.

Practical

Formulation of Questionnaire and conduct of survey on the availability of animal foods in selected areas. Effect of processing on sheep meat (moisture content, color change, shrinkage and sensory quality attributes). Curing of meat using sugar, salt and nitrite. Effect of tenderizing agents on meat cookery. Quality evaluation of processed meat and chicken products - preparation of

battered chicken. Pickling and canning of meat. Microbial quality of stored animal and chicken meat products. Visit to slaughter house and meat cold storage unit.

Suggested readings:

1. GOI. Annual Report. Department of Animal Husbandry and Dairying Ministry of Fisheries, Animal Husbandry and Dairying Government of India. Latest issues https:// gfi. org/ science/ the-science-of-cultivated-meat/
2. Ioannis, S. Boziaris. 2013. Seafood Processing Technology: Quality and Safety, 2013, Wiley and Blackwell Ltd.
3. Lawrie, R. A. and Ledwad, D.A. 2006. Meat Science. Woodhead Publishing Limited.
4. Kyriakopoulou, K., Dekkers, B., and van der Goot, A. J. 2019. Plant-based meat analogues. In *Sustainable meat production and processing* (pp. 103-126). Academic Press.
5. Kerry, Joseph, Kerry, John and Ledward, David. 2005. Meat Processing-Improving Quality. Woodhead Publishing Ltd., Cambridge, England.
6. Nanda, Vikas. 2014. Meat, Egg and Poultry Science and Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
7. NIIR Board of Consultants and Engineers. 2005. Preservation of Meat and Poultry. Asia Pacific Business Press, Inc., Delhi.
8. Sharma, B.D. and Sharma, Kinshuki. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
9. Stephens, N., Di Silvio, L., Dunsford, I., Ellis, M., Glencross, A., and Sexton, A. 2018. Bringing cultured meat to market: Technical, socio-political, and regulatory challenges in cellular agriculture. Trends in food science and technology, 78, 155–166. https:// doi. org/ 10.1016/j.tifs.2018.04.010.
10. Toldra, Fidel, Hui, Y. H. Astiasaran, Iciar Nip, Wai-Kit, Sebranek, Joseph G. Expedito-Tadeu F., Silveira, Stahnke, Louise H., and Talon, Regine. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
11. Tziva, M., Negro, S. O., Kalfagianni, A., and Hekkert, M. P. 2020. Understanding the protein transition: The rise of plant-based meat substitutes. Environmental Innovation and Societal Transitions, 35, 217-231.

Pulses and oilseeds: Processing and Technology 3 (2+1)

Objectives

1. To impart knowledge to the students on legume and oil seed processing
2. To make students able to develop good expertise on the technical aspects of dhal milling, oil milling and various legumes and oil seeds-based product preparations

Theory

Food uses of major pulses- Bengal gram, green gram, black gram, red gram, lentils etc. Primary processing of pulses- Cleaning, drying, storage, control of storage pests. Secondary processing methods-Dehulling, small scale processing, large scale processing. Traditional dal mills and modern dal mills, nutrient losses during processing. Processing methods of pulses like soaking, germination,

cooking, fermentation etc. Major oilseeds produced in India and their utility groundnut, rapeseed/ mustard, soybean, sesame seed, sunflower, safflower, cottonseed, linseed, caster. Pre-treatments and oil extraction from different oilseeds. Refining, bleaching, deodorization, hydrogenation processes of edible oils Anti-nutritional factors and toxic constituents of pulses and oilseeds. Technology of production of oilseed meals/flours, protein concentrates and isolates of pulses and oilseeds and their utilization. By product utilization of pulses and oilseeds.

Practical

Market survey of pulse and oilseed-based snack foods, Preparation of pulses and oilseed-based snack foods. Demonstrations on soaking, dehulling, germination, fermentation methods Analysis of antinutrients- Phytic acid, saponins, trypsin inhibitors etc. Preparation of snacks based on pulses and oilseeds. Preparation of recipes based on germinated and fermented pulses. Visit to traditional dal mills, modern dal mills, oil mills to expose students to dal milling operations and oil extraction operations.

Suggested readings:

1. Chakraverty, A. 1995. Post-harvest technology of cereals, pulses and oilseeds, 3rd edn. Oxford and IBH publishing co., Pvt. Ltd.
2. GOI. 2021. Agricultural Statistics at a Glance. 2021. Ministry of Agriculture and Farmers Welfare Department of Agriculture and Farmers Welfare Directorate of Economics and Statistics goi.
3. Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
4. Khader, Vijaya. 2001. Textbook of Food Science and Technology, Indian Council of Agricultural Research, New Delhi.
5. Raghuvanshi, R.S. and Bisht, K. 2010. Uses of Soybean: Products and Preparation. Guriqbal Singh (Ed.). In: Soybean: Botany, Production and Uses, CAB International, U.K.
6. Raghuvanshi, R.S. and Singh, D.P. 2009. Food preparations and use.
7. William Erskina *et al.* (Eds.). The Lentil: Botany Production and Uses. CAB International, U.K.
8. http://www.fao.org
9. http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=5933
10. https://agritech.tnau.ac.in/postharvest/pht_pulses_processing.html#:~:text=ProcessingA%20Processing%20of%20pulses%20is,of%20preparing%20pulses%20for%20consumption.

Sensory Evaluation of Foods 2 (1+1)

Objectives

1. To introduce the methodology used in sensory evaluation of food product
2. To expose students to the ability of humans to use their senses to evaluate the quality attributes of food product using sensory evaluation methods such as analytical and effective methods
3. To cover the use of relevant statistics in analyzing sensorial evaluation data

Theory

Sensory quality evaluation - introduction, method, sensory panel; physiological and psychological foundations of sensory evaluation; Principles of good practice: the sensory testing environment, test protocol considerations, Factors influencing sensory measurements, Basic principles: Senses and sensory perception, Physiology of sensory organs, Sensory and instrumental analysis in quality control. Sensory attributes of foods and beverages and their perceptions, appearance, flavor, taste, aroma, texture/mouthfeel, trigeminal sensations, Sensory evaluation methodology, threshold measurements, difference tests, scaling procedures, descriptive analytical methods, consumer tests, Instrumental measurements, color texture, flavor, Correlation of sensory and instrumental measures, Applications of sensory tests for quality assurance product development product optimization marketing. Objective methods of evaluation. Relationship between objective and subjective methods.

Practical

Determination of threshold value for basic tastes and odor; Odor recognition, difference (PC, Duo trio, triangle); Selection of judging panel; Training of judges, for recognition of certain common flavor and texture defects using different types of sensory tests; Descriptive analysis methodology; Texture profile methodology; Sensory evaluation of various food products using different scales, score cards and tests; Estimation of color; Designing a sensory laboratory.

Suggested Readings

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods.
4. Lawless, Harry, T. and Heymann, Hildegarde. 2010. Sensory Evaluation of Food: Principles and Practices. 2nd edn, Springer, New York or Dordrecht Heidelberg, London.
5. Marcel Dekker. y Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science and Technology and Nutrition. Vol. XI. Academic Press.
6. Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
7. Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.

S. No.	Course	Credit Hours
Elective-3 Institutional Food Service Management		
1	Institutional Food Service Management	3 (0+3)
2	Sensory Evaluation of Foods	2 (1+1)
3	Event Management	3 (0+3)
4	Food processing and packaging	4 (3+1)
5	Ergonomics in Food Service	2 (2+0)
6	Food Standards and Quality Control	3 (2+1)
7	Food Toxicology and Quality Testing	3 (2+1)
8	Print and Electronic Journalism	3 (0+3)
9	Tourism and Hospitality Management	3 (1+2)

Institutional Food Service Management 3 (0+3)

Objectives

1. To cover designing the kitchen and work space, selection of equipment and maintenance, personal and finance management, food management, hygiene and sanitation, menu planning and food composition and nutritional values
2. To help those who are interested in establishing a food service industry in making available hygienically prepared, wholesome and nutritious food to the consumers

Practical

Introduction to quantity food production, familiarization to equipment for quantity food production, Weight, measures and conversion, Recipe conversion standardization of recipes – procedure. Practical exercise on standardization of recipe, multiplication of standard recipe, portioning and cost calculation. Standardization of recipes suitable for different catering services i.e., cafeterias /canteens, snack bars, industrial canteens, residential hostels. Costing of recipes planned and fixing the price. Exercise on quantity food production for different type of food service establishments. Visit to residential hostel, hospital canteen, industrial canteen, star hotel and fast-food centre to observe the organization, management and administration. Making a detailed project report for establishing a food service unit including making purchase documents for equipment purchase and tenders etc. Organizing and planning menu for college canteen as a catering enterprise, setting up of a canteen, management of college canteen - procurement of materials. Practical exercise on food preparation, pricing and sale. Preparation and presentation of report on management of canteen. Catering for Birthday party/Mocktail Party/ Convention/ Seminar / Conference.

Suggested Readings

1. Fuller J. 1966. Chefs Manual and a Kitchen Management. B.T. Badtsford Ltd.
2. Raske L. 2017. Foodservice Management Fundamentals by Lina, Scitus Academics
3. Ratti M. 2000.Food Service Management. Neha Publishers and Distributors.
4. Sethi M and Malhan S. 1997. Catering Management - An Integral Approach. New Age International.
5. Treat N and Richards. 1997. Quantity Cookery. Little Brown and Co.
6. West BB, Wood L, Harger VF and Shugart GS. 1977. Food Service in Institutions, John Wiley and Sons.

Sensory Evaluation of Foods 2 (1+1)

Objectives

1. To introduce the methodology used in sensory evaluation of food product
2. To expose students to the ability of humans to use their senses to evaluate the quality attributes of food product using sensory evaluation methods such as analytical and effective methods
3. To cover the use of relevant statistics in analyzing sensorial evaluation data

Theory

Sensory quality evaluation - introduction, method, sensory panel; physiological and psychological foundations of sensory evaluation; Principles of good practice: the sensory testing

environment, test protocol considerations, Factors influencing sensory measurements, Basic principles: Senses and sensory perception, Physiology of sensory organs, Sensory and instrumental analysis in quality control. Sensory attributes of foods and beverages and their perceptions, appearance, flavor, taste, aroma, texture/mouthfeel, trigeminal sensations, Sensory evaluation methodology, threshold measurements, difference tests, scaling procedures, descriptive analytical methods, consumer tests, Instrumental measurements, color texture, flavor, Correlation of sensory and instrumental measures, Applications of sensory tests for quality assurance product development product optimization marketing. Objective methods of evaluation. Relationship between objective and subjective methods.

Practical

Determination of threshold value for basic tastes and odor; Odor recognition, difference (PC, Duo trio, triangle); Selection of judging panel; Training of judges, for recognition of certain common flavor and texture defects using different types of sensory tests; Descriptive analysis methodology; Texture profile methodology; Sensory evaluation of various food products using different scales, score cards and tests; Estimation of color; Designing a sensory laboratory.

Suggested Readings

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker. y Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science and Technology and Nutrition. Vol. XI. Academic Press.
4. Lawless, Harry, T. and Heymann, Hildegarde. 2010. Sensory Evaluation of Food: Principles and Practices. 2nd edn., Springer, New York or Dordrecht Heidelberg, London.
5. Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
6. Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.

Event Management 3 (0+3)

Objectives

1. To be aware of event management as a profession
2. To gain basic knowledge about establishing and managing an event
3. To understand and develop soft skills that would help in event management

Practical

Identifying practical situations for event management, conceptualizing goal and objectives, Overall show management. Exhibit sales and promotion. Festivals (diwali, religious ceremonies). Social gathering. Food fair/Conference/ workshop/seminar/congress programming. SWOT analysis of event. Portfolio preparation; presentation and projection for work. Project report on visit to different types of organizational settings like hotel, guest house, hostel, small offices, clubs,

fast food centres for management and organization of events. Project planning. program planning and execution. Project development. Event accountancy. Event communication and sponsorship. Event marketing and advertising. Live event management. Visit to different organizations/hotels etc. Project preparation and report presentation.

Suggested Readings

1. Narayna, Sulekha (2001) International Institute of Event Management. SNDT Women's University, Juhu Campus, Juhu Tara Road, Santacruz (W), Mumbai - 400 049.
2. National Institute of Event Management. Ground Floor, Nandavan Building, Corner of Vallabhbhai Road and Ansari Road, Vile Parle (W), Mumbai.
3. Potions, Kit and Bhuson, H.P. (1998). Festival and Special Event Management. IBM Cooperation, 60 Renfrew Drive, Suite 105, Markham, Ontario, Canada L3R0E1.
4. Sharma, Anukrati and Arora, Shruti (2018) Event Management and Marketing: Theory, Practical Approaches and Planning (English, Paperback)
5. Suvarna, Aditya (2003) Event Management Development Institute. I.E.S. Management College. 4th Floor, 791, S.K. Marg, Opp. Lilavati Hospital, Bandra (W), Mumbai - 400 050.

Food processing and packaging 4 (3+1)

Objectives

1. To impart knowledge of various areas related to food processing and packaging
2. To enable the students to understand food composition and its physic chemical, nutritional, microbiological and sensory aspects

Theory

Food processing and preservation techniques for cereals, milk, fruits and vegetables, oil seeds, meat, fish and poultry and their impact on physical and chemical characteristics. Physico-chemical characteristics, nutritional quality and shelf-life studies. Factors effecting quality of processed foods. Food packaging, package functions, requirement and packaging materials. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs.

Practical

Market survey for packaged processed food stuffs. Cereal cookery. Preparations showing dextrinization and gelatinization, gluten formation and influence factors. Vegetable cookery: effect of heat and alkali on pigment, preparation of soups, salads and beverages. Use of milk and milk products and egg in various preparations Estimation of shelf- life of packaged food stuffs.

Suggested Readings:

1. Frank, A., and Paine, H.Y. (2003). A Handbook of food packaging. Springer science and business Media, U.K.
2. Kalia, M. and Sood, S. (2010). Food preservation and processing. Revised edition, Kalyani Publishers, New Delhi.

3. Potter, N.N. (1996). Food science. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Srilakshmi, B. (2010). Food science (5th edn). New Age International Pvt. Limited Pub., New Delhi.

Ergonomics in Food Service 2 (2+0)

Objectives

1. To identify the current problems related to ergonomic in food production process
2. To understand and analyze the actual production data by using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA)
3. To recommend the ergonomic workplace environment based on the condition of the study

Theory

Introduction to Ergonomics, principles, domains, significance and applications, Functional design, Facility design, Work zones, Work flow and travel distance, Work triangle, Managing central kitchens, kitchen layout, kitchen storage, kitchen planning, kitchen forms, Equipment selection and cart selection and maintenance, Material selection and placement, Managing human resource issues, Operational issues, food safety and hygiene and service ware., Ergonomics for Waiter staff, Cooks, food preparation workers, dishwashers, Musculoskeletal disorders – meaning, causative factors. Common MSD in food industry- Awkward posture, repetition, force. Ergonomic injury signs, symptoms and reporting. Ergonomic Risk Factors and safety Trends in accidents, Task Specific Ergonomics. Safety Responsibilities, Safety Responsibilities of Employers, Employees and Health Care Providers, Ergonomics Solutions and Stress- Engineering Improvements, Administrative Improvements and Personal Protective Equipment.

Suggested readings

1. Brudger, R. S. (2003) Introduction to Ergonomics, Taylor and Francis London
2. California Department of Industrial Relations (2003) Ergonomics in Action: A Guide to Best Practices for the Food-Processing Industry, OSHA.
3. Dan Macleod (2006) The Ergonomics Kit. (Second Edition). Taylor and Francis, London.
4. Grandjean, E. (2000) Fitting the Task to the Man, Taylor and Francis, London
5. https://www.tdi.texas.gov/pubs/videoresource/fsergofood.pdf

Food Standards and Quality Control 3 (2+1)

Objectives

1. To develop qualified and competent human resource in the field of the food standards and quality management for regulators, industry, academic/research institutions, certifying and accreditation bodies, food trade, food testing and training
2. To delve in depth on various aspects of food standards and quality management i.e. food standards, harmonization with global benchmarks, quality management systems, food analysis, instrumentation, risk analysis /management, traceability and auditing to transform the food ecosystem

3. To nurture a positive and disciplined food standard and quality culture among the professionals
4. To conduct research studies on emerging food standard issues and formulation of science based regulatory framework

Theory

Importance of food quality control and assurance. Food Standards and Regulations in India: FSSAI, Prevention of Food Adulteration Act, Fruit Product Order, AGMARK, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards, Food and Drug Administration (FDA). Food additives, preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents Sensory Evaluation of Food Quality – Introduction -Panel Screening-Selection of Panel members. Objective/Instrumental analysis of Quality Control.Statistical Quality Control of Foods Determination of Sensory thresholds and taste Interactions. Fundamentals of Food regulations-pertaining to Additives and Contaminants. Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws Food packaging, packaging material. Adulteration, heavy metals. Quality criteria of foods – food grains, fruits, vegetables and animal foods. Quality criteria of processed foods. Physical, chemical and microbial contamination of foods. Food adulteration – common adulterants – health hazards. Tests to detect adulterants in food. Pesticides-Mechanisms of Toxicity-Residues in Food, Acceptable daily limits.

Practical

Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products. Identification of food logos. Study of food labelling. Identification of critical control points in a product line. Sensory evaluation of different food samples. Visit to quality control laboratory/food processing industries and note the procedures and parameters used for quality assessment. Estimation of quality parameters- cereals, pulses, fruits and veg. Market survey and quality analysis of street foods. Estimation of quality parameters – cereals, pulses, fruits and vegetables - Evaluation of food quality – objective and subjective methods - Market survey and quality analysis of street foods -

Suggested Readings

1. Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011.
2. Jellinek, G. 1985. Sensory Evaluation of Foods: Theory and Practice. Ellis Honwood Ltd. Chichester, England.
3. Kalia, M. and Sood, S. 2010. Food Preservation and Processing. Revised edn. Kalyani Publishers, New Delhi
4. Manual of Food Standards and Quality Control. 2014. Dept. of Foods and Nutrition, CCS HAU, Hisar. Detect Adulteration with Rapid Test (DART) booklet fssai https://www.fssai.gov.in/flipbook.php?bookid=201#book2/7
5. Patricia and Cuuring A. An operational Text book, guide to Food Laws and Regulations.
6. Potter, N.N. 1996. Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
7. Radonit, Lassztity. 2008. Food Quality and Standards. Encyclopedia of Life effort systems. USA.

Food Toxicology and Quality Testing 3 (2+1)

Objectives

1. To give an introduction to possible toxic effects of food additives and naturally occurring environmental toxins in food.
2. To make students able to define toxicology
3. To make student able to define the most important contaminants in food, the toxicology of various additives and environmental toxins, as well as their sources
4. To explain what food safety is and which substances are of relevance for food safety
5. To explain to students what risk analysis, assessment and management in relation to food safety is, and know which organizations are involved in this type of work nationally and internationally

Theory

Food toxicology – definition, introduction and significance. Classification of toxic constituents. Food poisoning –types, causative factors, signs and symptoms, preventive measures. Natural food toxins – pulses, oil seeds, sea foods, processed animal foods. Anti-nutritional factors, other food toxins, their harmful effects and methods of removal. General characteristics, occurrence, properties and inactivation of protease inhibitors, trypsin inhibitors, haemagglutinins, goitrogens, gossypol. General characteristics, occurrence, properties and inactivation of saponins, lathyrogens, avidin and other antimetabolites. Microbial toxins – classification, source of contamination, effect on health, preventive measures, methods of inactivation / destruction. General characteristics, occurrence and properties of mycotoxins, aflatoxin, ochratoxin and patulin. Methods to detect and prevention of mycotoxins. Chemical toxins – Pesticides - Pesticide and insecticide residual toxicity – sources and health hazards, insecticides, metallic and others. Mineral toxicity – Chlorine and Fluorine, Heavy metals toxicity – Lead and Chromium, Mercury, Arsenic and Iron, residual effects, preventive measures, methods of removal. Food additives – classification, toxicity and effects. Toxins developed during processing. Food packaging material – Potential contaminants from food packaging material. Antibacterial drugs, hormones and growth promoters of animal origin. Detection of toxins in food chain.

Practical

Methods of detect aflatoxin and gossypol**.** Methods of detect trypsin inhibitors and protease inhibitors. Use of AAS for detection of lead, chromium, mercury, arsenic, iron, detection of tannin and phytic acid. Visit to toxicology lab and public health laboratory. Visit to Quality Testing Laboratory, food processing industry/ government laboratory.

Suggested readings:

1. Bjeldanes 2016. Food Toxicology, CRC Press.
2. Derelanko M.J. and Hollinger M A. 2002. Handbook of toxicology, 2nd ed., CRC Press.
3. Damodaran, Srinivasan, Parkin, Kirk L. and R. Fennema, Owen. 2007. Fennema's Food Chemistry, Fourth Edition. Taylor and Francis.
4. Ernest Hodgson. 2004. A Textbook of Modern Toxicology. John Wiley and Sons, IncI.

5. Robertson, Gordon L. 2006. Food Packaging Principles and Practice, 2nd Edition, CRC press. London.
6. Shibamoto Takayuki and Leonard F.. 2012. Introduction to Food Toxicology. Academic Press.
7. Compendium_Food_Additives_Regulations_08_09_2020-compressed.pdf (fssai.gov.in).
8. http://www.fda.gov/downloads/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathog
9. ensNaturalToxins/BadBugBook/UCM297627.pdf
10. http://www.fda.gov/
11. www.standardsdata.in/
12. www.fssai.gov.in
13. http://www.foodqualitynews.com/
14. http://www.cdc.gov/

Print and Electronic Journalism **3 (0+3)**

Objectives

1. To develop the learner into competent and efficient in the field of reporting news, processing and program production in the field of media
2. The Subject is designed to make the students learn about script, interviews techniques, phone-ins, panel discussion, voice over, live shows and field reporting

Practical

Visit to print and electronic stations for familiarization with equipment's, Interaction with personnel of print and electronic media. Report writing on observations and presentation. Planning a press note/ press release for print media, Screening of radio news programs. Screening of TV news programs. Exercises on writing different types of reports for radio. Exercises on writing different types of reports - television formats, Hands-on experience with editing. Planning a press note/ press release for electronic media, Writing and presentation of radio and television news, Orientation to photography/videography and its equipment. Hands on training with different types of professional cameras, Writing captions for photographs. Writing and editing photo features for selected photographs and presentation. Familiarization with different online articles. Content creation for online journal. Creating a blog, awareness videos. Using social media channels such as Facebook/ Instagram/ LinkedIn/ Twitter/ WhatsApp, to create nutrition related post.

Suggested readings

1. Bhatt, S.C. (1993) Broadcast Journalism. Basic Principles Har Anand Publications, Delhi
2. Bhatnagar, R. (2001). Print Media and Broadcast Journalism. Indian Publisher Distributors, Delhi
3. Fernández-Celemín, L., and Jung, A. (2006). What should be the role of the media in nutrition communication? British Journal of Nutrition, 96(S1), S86-S88. doi:10.1079/BJN20061707
4. Katyal, V.P (2007). Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.

5. Kumar A. (1999). The Electronic Media. Anmol Publications, New Delhi.
6. http;//hosbeg.com.printmedia.an
7. https;//www.vskills.in certification
8. https://www.nyfaedu.print.journal.

Tourism and Hospitality Management **3 (1+2)**

Objectives

1. To learn skills associated with problem solving, creative and critical thinking; related to tourism industry
2. To applying the concepts and skills necessary to achieve guest satisfaction
3. To demonstrate knowledge of multi - cultural perspectives to meet the needs of the guests and employees
4. To lead with the knowledge that the foundation of tourism and hospitality is based on the respect for the host culture with the responsibility to perpetuate unique values, traditions, and practices of that place
5. To demonstrate ability to perform basic and supervisory level job functions in hotel and restaurant careers

Theory

Tourism Management Introduction to Tourism, Growth and development of modern tourism, Tourism in India, Heritage/ Cultural, Pilgrimage Tourism, Medical, Hot Spots and Culinary Tourism -Business and Cruise Tourism - Eco-tourism/ Rural tourism - Emergence of Eco-tourism / Rural tourism - Concept and definitions - Growth and development issues in eco-tourism - Travel Agency and Tour Operation and logistics (Airlines operation and ticketing. Ships cruise services) business in India, Emerging trends of tourism, Impacts of Tourism, Ethics issues in tourism - Introduction to Hospitality Management. Basic Management Principles: planning, organizing, staffing, leading, controlling with specific reference to hospitality. Hotel hierarchy: GM, departmental heads, supervisors, operational employees Soft Skills in Hospitality; personal development, motivation. Communication techniques and skills, Hostess training Services offered to guests such as food and accommodation services and personal services Front Office management. Maintenance of front office records - housekeeping services - cleaning and linen services, bed making Accommodation Operations - Role of accommodation operations in hospitality. Public areas – maintenance and decoration

Practical

Study of all the activities of a tourism office and report Planning for a tour - Heritage, Eco, Wildlife, Pilgrimage, medical etc. - Planning for Accommodation operations - Preparation of a tour package - Visit to different tourist spots - Planning layouts of front office of different institutions - Mock sessions on front office handling - Mock sessions on Communication Techniques and Skill - Mock sessions on Handling Complaints and Emergencies - Mock sessions on Handling various types of clients - Practical sessions on Hostess training - Services offered - Practical sessions on housekeeping services - Report writing.

Suggested Readings

1. Dharmarajan, S. and Seth, R., Tourism in India-Trends and Issues, Har Anand Publications Pvt. Ltd. New Delhi, 1st edn.
2. Gupta, S., World Tourism in New Millennium, ABD Publishers, Jaipur, First edition.
3. Kamra, K. K. and Chand, M. 2006. Basics of Tourism-Theory, Operation and Practice, Kanishka Publishers, New Delhi. First Edition.
4. Maken. D. Strategies and Planning in Tourism and Industry, Adhyayan Publishers and Distributors, Delhi, r 1st edn.
5. Puri, M. and Chand, G. 2006. Tourism Management, Pragun Publications, New Delhi. 1st edn.
6. Roday, S., Biwal, A. and Joshi, V., 2009. TOURISM Operations and Management, Oxford University press publication, New Delhi, Fir 1st edn.
7. Sharma. R.B. World Tourism in 21st Century, Alfa Publications, New Delhi, 1st edn.

SKILL ENHANCEMENT COURSES (SEC modules)

Broad course syllabi for SEC, Institutions may modify, add more courses as per the expertise and need of the area; the courses may be conducted by the institution or in partnership with any organization

Indicative list* of SEC Modules

S. No.	Course Title	Credit Hours
1.	Jam Jelly Preparation	2 (0+2)
2.	Cake Making	2 (0+2)
3.	Indian Traditional Sweets	2 (0+2)
4.	Cake Decoration and Icing	2 (0+2)
5.	Pickle Preparation	2 (0+2)
6.	Candy Making	2 (0+2)
7.	Savory Snack Preparation	2 (0+2)
8.	Ready to Eat Snacks	2 (0+2)
9.	Hygiene Management in Food Service Units	2 (0+2)
10.	Quality Control in Food Processing Units	2 (0+2)
11.	Web Designing and Multimedia Production	2 (0+2)
12.	Development of Nutritional Educational Material	2 (0+2)
13.	Development of Audio-Visual Aid	2 (0+2)
14.	Sugar Processing and Confectionary	2 (0+2)
15.	Assessment of Clinical Signs and Symptoms	2 (0+2)
16.	Development of Project Proposals	2 (0+2)
17.	Laboratory Analysis	2 (0+2)
18.	Practical Skills in Writing And Speaking	2 (0+2)

*University/HEI may offer courses in any area as identified by it, based on institutional expertise/ capabilities/resources. In addition, SEC list as suggested by UGC is given in item IV listed under 3.1.12 are also suggested.

Jam Jelly Preparation 2 (0+2)

Practical

Nutritional aspect of Fruits; Basic characteristics of jams, jellies, marmalades, fruit preserves, glazed and crystallized fruits; Role of sugar and other ingredients in fruit preservation; Introduction to various food additives used in jams, jellies and other fruit preserves; Basic tools and equipment used in the preparationof jams, jellies and crystallized fruits such as pulper, sealers, juice extracting machines, autoclaves, steam jacketed kettle, etc.; Introduction to different types of packaging materials used.

Identification of different types of spoilage occurring in fruits; Selection and grading of raw and ripe fruits for preservation; Preparation of Jam, jelly and marmalades - ripe mango, green mango, pineapple, apple, guava, orange, mixed fruits, etc.; Preparation of glazed and crystallized fruit preserves- ginger, orange, apple, etc.; Analysis of the raw material and finished product - Pectin grade, Acidity of fruit juice and pickle, Total Solid content, Brix measurement, Moisture content, Ash content, reducing and non-reducing sugar content. Study on the shelf life of the finished product.; Basics of labeling, packaging and presentation of sweets; Waste Management and up keeping of work place.

Cake Making 2 (0+2)

Practical

Ingredient used in Cake Making Types and Varieties: Flour, Sugar, Shortening – Fats and oil, Egg, Moistening agent, Leavening Agents; Cake Making Methods: Sugar butter process, Flour butter process, Genoise method, Blending and rubbing method; Characteristic of Cakes: External characteristics, Internal Characteristics; Balancing cake formula; Cake Faults and remedies; Basic Cake Making: Plain Sponge, Madeira Cake, Rock Cake, Fruit Cake, Fatless Sponge, Swiss Rolls, Genoise Sponge; Market survey for cake and confectionary food stuffs; Project writing of small-scale bakery and confectionery unit

Indian traditional sweets 2 (0+2)

Practical

Basic ingredients and their role in preparation different types of traditional sweets; Basic tools and equipment used in the preparation sweets; Stages of Sugar cookery; Preparation of Bengali sweets like- Rasogolla, Rajbhog, Rasbhari, Chamcham, Rasomalai, Sandesh Raskadam, Mohanbhog, Kheer Mohan and Channa Toast; Preparation of milk and khoya based sweets like- khoa Burfi, chocolate burfi, khoa peda, kesar peda, pista burfi, badaam pista burfi , kesar khoa burfi, kalakand, milk cake, khoa roll, kheer kadam, coconut burfi, meva bati etc.; Preparation of ghee based sweets -Patisa, Gulab Jamun, Soan Papdi, Gujia, Imarti, Motipak, Balushahi, Laddu; Preparation of khaju and dry fruits based sweets like-Kaju Burfi, Kaju Roll,Kaju Laddu, Badam Burfi, Pista Lauj and Anjeer Burfi etc.; Basics of labeling, packaging and presentation of sweets; Waste Management and up keeping of work place

Cake decoration and icing **2 (0+2)**

Practical

Techniques of Icing –ingredients used in icing and their role; Tools of icing, preparing, and applying various types of icing; Icings and Toppings; Fondant; American frosting; Butter cream icing; Royal icing; Gum paste, marzipan; Marshmallow; Lemon meringue; Fudge, almond paste; Glace icing.

Pickle preparation **2 (0+2)**

Practical

Nutritional aspect of fruits and vegetables; Basic characteristics of pickles; Role of various ingredients used in fruit and vegetable preservation; Introduction to various food additives used in pickle making- Spices and other constituents, condiments and other additives and ingredients, and flavouring, colouring agent and preservative; Basic tools and equipment used in the preparation of pickle making such as boilers, choppers, mechanized peelers, sealers, autoclaves, steam jacketed kettle, pickle mixer, etc.; Introduction to different types of packaging materials used; Identification of different types of spoilage occurring in fruits; Selection and grading of raw and ripe fruits and vegetables for preservation; Preparations of different types of pickles from fruits and vegetables- (i) Preparation of salty and oily pickle (green mango, green chili, lemon, ginger, mixed type), (ii) Preparation of sweet pickle (mango, plum, papaya, date, mango lather, mixed type etc.); Examination of processed products- Examination of processed products- Detection of benzoic acid, sulphur dioxide and KMS in fruits and vegetable products. Cleaning and maintenance of the equipment; Study of containers like Glass, Tin, packaging materials, such as plastic pouches, glass containers, plastic bottle and cartons; Information to be mentioned on label and pack; Waste Management and up keeping of work place.

Candy making **2 (0+2)**

Practical

Introduction to candy making; Basic ingredients and their role in preparation different types of candies; Basic tools and equipment used in the preparation of candies; Stages of Sugar cookery, caramelization of sugar, crystallization of sugar, invert sugar, corn syrup; Preparation of: Ganache- Ganache techniques and uses, -Various types of ganache, How to work with ganache, Piped and Filled Truffles- Making various recipes of ganache used for piped truffles and filled truffles; Tempering chocolate, Slab Ganache, Finishing truffles - Tempering white, milk and dark chocolate; Molded Truffles- Producing chocolates using shell molds and slabbing with metal bars, Learn how to prepare and decoratively color molds before filling, Cut ganache slabs with use of guitar, proper dipping and finishing technique with tempered chocolate, including use of transfer sheets; Finish all Truffles- How to store and freeze finished Truffles; Candy Bars- Discussion of different characteristics of a candy bar, History and popularity of the Candy bar, How to Assemble a candy bar; Jellies and Pate de Fruit- Learn the differences between the use of gelatin and pectin in gummy candies, Preparation of jellies and Pate de fruit; Crystalline Confections- Learn how the crystallization of sugar creates candy, Preparation of different Fondants and Fudges; Preparation of Chocolate Eggs; Basics of labelling and packaging , Waste Management and up keeping of work place.

Suggested Reading

1. Chocolates and Confections, 2nd edn by Greweling Publisher: Wiley, ISBN: 9780470424414

Savory Snack preparation 2 (0+2)

Practical

Market survey for availability of different types of savory snacks; Preparation of snacks with some shelf life: Types of Namkeen; Preparation of Chiwda; Chakli preparation and its variations; Preparation of mathri in different flavours; Gathiya preparation; Preparation of snacks eaten when prepared: Khaman and Dhokla with chutnies; Preparation of Dahi Vada and its chutnies; Making types of bhelpuri; Making Corn bhel/Chat; Preparations of Sago: Sago Vada and Sago Khichadi; Frying skills by preparing types of fritters and potato twisters; Cutlet preparation with various variations; Preparing Sprout Chat and Masala Peanut; Preparation of Garlic bread, Focaccia and Bruschetta; Project writing of small scale savory snack production unit.

Suggested Readings

1. Brown, A. (2018). Understanding Food: Principles and Preparation. Wadsworth Publishing Co Inc.
2. Pant, P. (2007) Cuisines – Incredible India. Wisdom Tree, India.
3. Richard, E. Martland and Derek A. Eelsy. (1998). Text book of Basic cookery, Fundamental recipes and variations.
4. Sethi, M. (2007). Catering Management – An Integrated approach. New age International (P) Limited Publishers, New Delhi.

Ready to Eat snacks 2 (0+2)

Practical

Introduction to convenience foods based on various food groups; Selection of raw materials, Overview of various food additives used for snacks; Preparation of Grain/pulse based snacks: whole grains –roasted, toasted, puffed, popped and flakes Coated grains-salted, spiced and sweetened Flour based snack–batter and dough based products; savoury and farsans; formulated chips and wafers, papads; Preparation of fruit and vegetable based snacks: chips, wafers, papads etc. , ready to eat fruits and vegetable based food products like, sauces, fruit bars, glazed candy etc., ready to eat canned value added fruits/vegetables and mixes and ready to serve beverages etc.; Preparation of Dairy based convenience foods; Preparation of ready-to-eat baked food products, drying, toasting roasting and flaking, coating, chipping. Preparation of coated nuts –salted, spiced and sweetened products-chikkis, Singh bhujia; Extruded snack foods: Formulation of cold and hot extruded snacks, assessment of quality; Food packaging material for snack foods, Food labels; Visit to snack making plant.

Hygiene Management in food service units 2 (0+2)

Practical

Introduction, importance and need of food hygiene and sanitation if food service establishments; Identification of microorganism, preparation of slides, preparation of media; Collection of water

samples, Testing of water for: (i) Physical quality, (ii) Bacteriological quality, (iii) water hardness; Food-Borne Diseases- Define Food-Borne illness – Food Infections – Food Poisoning- Bacterial infections -Types of Food Inspections; Sanitary Procedures in Catering Industry- Sanitary Procedures for purchasing foods - categories of commodities – Storage areas Temperature Zones- Thawing, Blanching, maceration, Blast, Freezing, Pasteurization; Introduction to Daily Cleaning Procedures in Commercial Kitchen; Visit to food service establishments; Survey of food service establishments, data collection, tabulation, report writing and presentation.

Quality control in food processing units **2 (0+2)**

Practical

Concept of quality control and quality assurance in food processing industry; Food and nutrition labelling on foods as per FSSAI regulations and international standards; Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws Food packaging, packaging material; Evaluation of food quality – Assessment of quality of some finished foods through objective and subjective methods; Market survey and quality analysis of street foods; Visit to food processing Units to understand the quality control methods used while processing food; Simple physical and chemical tests to determine quality and detect adulterants in Oil and Fats, Spices and Condiments (any five), Food Grains, Pulses and Oilseeds, Flours – Wheat, Canned foods – Drained wt., Sugar and Honey, Milk and Milk products, Tea, Coffee; Report writing.

Web Designing and Multimedia Production **2 (0+2)**

Practical

Study of creating Webpages using HTML elements like <html>, <head>, <title>, <body>, <u>, <b>, <i>,

<p>, <marquee>, <br>, <ol>, <ul> with all its attributes. Familiarization with different types of websites, Hands-on-experience with Adobe photoshop for designing of website, Hands-on-experience with HTML

4.01 writing for construction of website, Hands-on-experience with Dreamweaver for construction of website. Hands-on-experience with flash for animations of website, Familiarization with cascading sheet styles. Familiarization with web analytics, Practical orientation to Multimedia application. Exposure to multimedia hardware and maintenance-parts and connection, peripheral. Handling multimedia-parts, connections and peripheral. Scanning, retrieval, capturing and navigating skills. Planning and Production of multimedia package, Multimedia authoring tools - CD and DVD writing techniques, Presentation of the prepared Multimedia kit by using LCD Projector.

Suggested Readings

1. Frain and Ben. Responsive Web Design with HTML5.
2. Jennifer Niederst Robbins. Developing web design latest edition.

Development of Nutritional Educational Material **2 (0+2)**

Practical

Objectives, principles and importance of nutrition education in a community; Deficiency diseases and public health problems-Vit. A, iron and iodine deficiencies, other micronutrient

deficiencies; Identification of nutritional problems and target groups (Survey); Communication techniques: Process, its components. Mass, group and individual Communication; advantages and disadvantages; Classification and use of audio-visual aids (Electronic aid, non-projected and three dimensional); Preparation of instructional material (Chart, Poster, Flipbook, Pamphlet, Calendar); Practicing and use of nutrition education material on vulnerable groups in the community, rural and urban; Planning and organizing nutritional education program for community; Evaluation of nutrition education program.

Development of Audio-Visual Aid **2 (0+2)**

Practical

Introduction, need, importance of audio-visual aids; Classification of AV aids, characteristics, advantages and disadvantages of different types of AV aids; Principles to be followed for the effective use of AV aids; Development of various types of AV aids (digital/non digital) like flash cards, posters, charts, puppets, video spots, podcasts, role plays, cultural programs like folk songs etc.; Field testing of the developed AV aids.

Sugar Processing and Confectionary **2 (0+2)**

Practical

Introduction to Sugars: Composition and nutritional Composition; Types, properties and functions of Sugars; Identification and description of different stages of Sugar; Demonstration of 1 thread, 1.5 thread 2 thread consistency of sugar and Caramelization; Preparation of sweets using 1 thread sugar syrup (Gulab jamun, Makhanvada, Jalebi, Besan chakki, Ghewar etc.); Preparation of sweets using 1.5 thread and 2 thread sugar syrup (Kaju Katali, Shakkarpare, Mava petha, Gujia etc.); Preparation of Fondant and Fudge (Cake, Chocolate fudge etc.); Preparation of Toffee (Milk toffee, Chocolates, Stick jaws, liquor Chocolates etc.); Basics of labeling, packaging and presentation of sweets and confectionary products; Storage and preservation of sweets and confectionary products

Assessment of Clinical Signs and Symptoms **2 (0+2)**

Practical

Preparation of list of signs and symptoms of PEM; Preparation of poster on signs and symptoms of vitamin deficiency; Preparation of folder on mineral deficiencies; Visit to Aanganwadi to assess signs of PEM deficiency in children; Visit to hospital to assess the deficiency signs and symptoms in pregnant women; Survey of adolescent boys and girls to assess micronutrient deficiency; Assessment of clinical signs and symptoms of malnutrition in school age children; Nutrition education to target groups on micro nutrient deficiency; Visit to local health centre to identify clinical signs and symptoms of nutritional problems; Community survey for nutritional deficiency disorders – data collection ,tabulation analysis, interpretation, report writing; Presentation of reports and group discussion; Comparison of data on status of various deficiency diseases in India (NFHS 3, NFHS 4, NFHS 5) in vulnerable groups; Development of tools for assessing signs and symptoms of micronutrient deficiency in vulnerable groups; Collection of data on locally available common foods and their cost and unavailability of certain foods leading to the deficiencies in particular region; Surveillance of national nutrition programs; Data analysis and Report writing.

Suggested Readings

1. Bamji M.S., Prahlad R. N. and Vinodini R.2003. Text book of Human Nutrition. New Delhi, Oxford and IBH Publishing Co. Pvt. Ltd.
2. Das S. 2022. Textbook of Community Nutrition. Academic Publishers.
3. Mason J. B., Habicht J., Tabatabai H. and Valverde V., 1984. National Surveillance WHO.
4. Sehgal S. and Raghuvanshi R. 2007. Text Book of Community Nutrition. ICAR Publication.

Development of Project Proposals 2 (0+2)

Practical

It will be a group activity of 3-5 students in each group –

The students will do the background research on the project, will present an oral report, write and submit a formal project proposal on related aspects of food processing, dietetics, community nutrition, nutrition education, etc. The students are expected to: Identify an appropriate and manageable topic. A concise statement of objectives and what you intend to design and build will be one of the outcomes of the course. Conduct a background history of the topic and a current literature search of the topic. Students are expected to search in journals, magazines and Internet. This background report will be submitted with the project proposal. Budget development. Project work plan and timeframe (including GANTT charts). Monitoring and evaluation plan. Management Plan and Institutional Capability. Prepare the proposal appropriate to the objectives of the project with budgetary details, and submit a complete written proposal.

Laboratory Aanalysis 2 (0+2)

Practical

Unit-1: General introduction to laboratory glass wares. General introduction to the laboratory instruments. Preparation of samples and buffer solutions. Qualitative and quantitative analysis of carbohydrates. Qualitative analysis of amino acids. Qualitative analysis of protein. Qualitative analysis of fat. Determination of milk quality by MBRT test; Unit-2: Estimation of bulky density of food stuffs. Estimation of color by spectroscopy. Physical analysis- specific gravity. Determination of food quality by standard plate count method. Estimation of reducing and non-reducing sugar. Estimation of starch digestibility. Estimation of minerals by UV spectrophotometer. Determination of acid values; Unit-3: Quantitative estimation of proximate principles- Estimation of moisture in food stuffs. ash minerals, Estimation of nitrogen by khjeldal method. Estimation of fat by soxhlet method. Estimation of carbohydrate by difference; Unit-4: Saponification and iodine number. Preparation of culture media. Isolation and enrichment of microorganisms. Isolation of mould from different food samples. Microbial examination of – milk products, Cereal and pulses, vegetables and fruits.

Suggested Readings

- Pomeranz Y and Molean CE. 1977. Food analysis theory and practical. AVI publication.
- Sawhney SK and Singh R. 2000. Introduction practical biochemistry. Noroda.

Practical skills in Writing and Speaking **2 (0+2)**

Practical

Reading and Comprehension: Unseen Passage and Unseen Poems; Assessment of basic grammar: Worksheets on Articles, Verbs, Punctuations, Prepositions and conjunction; Worksheets on Tenses: Present tense; Simple present tense, Present Continuous Tense, Present perfect tense, Present Perfect Continuous Tense; Worksheets on Past Tense- Simple past tense, Past Continuous Tense, Past perfect tense, Past Perfect Continuous Tense; Worksheets on Future Tense- Simple future tense, Future Continuous Tense, Future perfect tense, Future Perfect Continuous Tense; Writing of letters – Informal letters, Formal letters, Emails; Notice writing / Advertisement; Essay writing; Story writing; Dairy Entry / CV writing; Writing of Blogs and technical articles; Oral Presentation skills; Extempore; Note taking and Summarizing; Individual presentations / Radio talks; Group presentations and Discussions.

Suggested Readings

1. Kumar S. and Pushpa L. 2011. Communication Skills. Oxford University Press.
2. Seely J. 2005. Oxford Guide to Effective writing and speaking. Oxford University Press.
3. Thomson A. and Martinet A.V. 1977. A Practical English Grammar. Oxford University Press.

ONLINE COURSES

In addition, students will have to opt for minimum 10 credits onlione courses(as per UGC guidelines for online courses) as a partial requirement for the B.Sc(Hons.) Food Nutrition & Dietetics

Suggestive list of on-line courses SWAYAM Portal

1- Food chemistry
2- Food fortification
3- Food microbiology
4- Food microbiology and Food safety
5- Food preservation Technology
6- Food and Nutrition
7- Food Laws and standards
8- Functional foods and Nutraceuticals
9- Fundamentals of food process engineering
10- Thermal processing of Foods
11- Dairy and Food process and product technology
12- Adolescent nutrition
13- Basics of nutrition
14- Mother health and Nutrition

PG Pathshala

1- Food safety and quality control
2- Food preservation

3- Principles of food processing
4- Innovation in food packaging
5- Food biotechnology
6- Food science
7- Macronutrients
8- Micronutrients
9- Human physiology
10- Nutritional biochemistry
11- Functional foods and nutraceuticals
12- Nutrition through life span
13- Nutrition wellness and fitness
14- Therapeutic nutrition
15- Research method in nutrition

Courses on Nutrition (Available on mooc.org (edx))

1. Nutrition and cancer- Wageningen X
2. Nutrition, Heart Disease and Diabetes- Wageningen X
3. Plant Based diet: Food of a sustainable future- Wageningen X
4. Nutrition and Health: Human Micro biome- Wageningen X
5. Nutrition and Health- Food Safety- Wageningen X
6. Nutrition and Health: Micronutrient and Malnutrition- Wageningen X
7. Nutrition and Health: Macronutrient and Over Nutrition- Wageningen X
8. Nutrition Exercise and Sports- Wageningen X
9. Feeding a hungry planet: Agriculture, nutrition and sustainability- SDG Academy X
10. Introduction to Food and Health- Stanford online
11. Mental health and nutrition- UCX
12. Sustainable food security: food Access- Wageningen X
13. Staying fit- Stanford online
14. Lifestyle management treatment of chronic disease- Part1- Doane X
15. Lifestyle management treatment of chronic disease- Part2- Doane X
16. The health effect of clinic change- Harvard X
17. Global Public Health- SDG Academy X
18. Sustainable food system: A Mediterranean perspective- SDG Academy X
19. Early childhood development: global strategies for implementation- Harvard X
20. Beer- the science of brewing- KULeuvenX
21. Fitness corporative
22. Sustainable global food systems

Courses on Nutrition (Available on IGNOU portal)

1. Diploma in nutrition and Health education
2. Certificate in nutrition and childcare
3. Certificate in Foods and Nutrition

Suggested Institutions / areas for Internship in Nutrition

1. Sports Authority of India (SAI)
2. Agricultural and Processed Food Products Export Development Authority (APEDA)
3. Food Safety and Standards Authority of India (FSSAI)
4. Centre For Health Research and Development, Society For Applied Studies
5. Defense Institute of Physiology and Allied Sciences (DIPAS)
6. Public Health Foundation of India (PHFI)
7. WHO, Internship program (WHO)
8. Hospitals- AIIMS, Apollo, Max, Fortis, Medanta, Etc.
9. Food Industries- Britannia, Perfetti, Pepsico India, Coca Cola, Haldirams, Bikaner
10. World Bank- Young Professional program (WBG)

SERICULTURE

Course Curricula for Undergraduate Program in Sericulture UG- Certificate in Sericulture UG- Diploma in Sericulture B.Sc. (Hons.) Sericulture

INTRODUCTION

Sericulture is an agro-based industry. It involves cultivation of host plants and rearing of silkworms for the production of cocoon to produce raw silk. The major activities of sericulture comprise food-plant cultivation to feed the silkworms which spin silk cocoons and reeling the cocoons for unwinding the silk filament for processing, and weaving to produce the valuable products.

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, light weight, soft touch and high in durability. Because of these unique features, silk is known as the "Queen of Textiles" all over the world. Besides, it stands for livelihood opportunity for millions, owing to its high employment potential, low capital requirement and remunerative nature of its production. The very nature of this industry with its rural based on-farm as well as off-farm activities and enormous employment generation potential has attracted the attention of the planners and policy makers to recognize the industry among one of the most appropriate avenues for socio-economic development of a largely agrarian India economy.

Sericulture industry provides employment to approximately 8.7 million persons in rural and semi-urban areas in India. India has the unique distinction of being the only country producing all the five known commercial silks, namely, Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga, of which Muga which is produced only in India with its golden yellow glitter is a prerogative of India. In India, because of prevalence of favourable climatic conditions, sericulture is being practiced in five states, viz., Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and Jammu and Kashmir.

Present report is an outcome of the valuable suggestions and recommendations of Sixth Deans' Committee members after having multistage in-depth deliberations and discussions in virtual meetings with the members of four sub groups representing departments / divisions of Sericulture Science, Stakeholders from related Universities, Sericulture experts and also passed out undergraduate students of the existing degree program across nation.

Restructuring of Undergraduate programs in Sericulture has been carried out as per NEP guidelines to build among students' strong foundation of knowledge

with increased practical exposure and skill Development to build competence and confidence for the application of the gained knowledge.

More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses via electives offered in fourth year and also through online courses along with provision of advanced skill development through project work or experiential learning, etc., with amalgamation of multiple exit and entry options as per NEP.

The details of the course structure for the Undergraduate courses in Sericulture (UG-certificate, UG-Diploma, B.Sc. (Hons.) Sericulture) have been prepared after having multistage in-depth deliberations and discussions. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The whole course program of 4 years under-graduate program in Sericulture will be of 177 credits, which will have 167 credits offered by the parent university and 10 credits of online courses to be taken by the student as per his/ her/ze choice.
- After the admission of students in the university, the students will register for the Foundation FC* = Foundation Course, at the start of first semester, which will be of 02 weeks duration.
- The course will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, University academic and research managers besides classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.
- Steps will be taken to identify the strength and weakness of students (with remedial measures) along with diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- Student will have to do common courses under categories like Multi-disciplinary, Value added, Ability enhancement courses etc. NSS/NCC will be of 2 credits.
- The first two years of the course program are dedicated for skill development in Sericulture discipline through skill enhancement courses along with basic and fundamental courses.
- The skill enhancement courses (SEC) of 12 credit hours will be offered during the first and second year of the degree program with full flexibility to the student as per NEP guidelines.
- There are four different 'SEC' modules of 12 credits hours, each to be offered one in each semester in a sequential manner, like SEC module-1 (0+4) in first semester, SEC module-2 (0+4) module in second semester, SEC module-3 (0+2) in third semester and SEC module-4 (0+2) module will be offered in fourth semester.
- The students will have flexibility and choice in selection of skill development area from a basket of "SEC" modules offered by the parent institute. Each of the SEC module offers skill development areas of related domains of Sericulture for the students. After one-week common orientation on different skill enhancement modules, students will take up one module as per the local needs and gain complete hands-on experience on the selected module.

- In addition, University /HEIs may also offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources.
- List of skill enhancement courses (SEC), suggested by UGC, given in item 4 listed under 3.1.12 is suggestive. Any of these courses can be considered for inclusion under SEC category.
- In first year, after satisfactory completion of 45 credits of courses in two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Sericulture on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the practical exposure as well as some part of the fundamental courses related to Sericulture with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of Sericulture. After satisfactory completion of 39 credits of courses in 3rd and 4th semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Sericulture on exit.
- The students continuing the study further, would not have to attend the internship after 2nd year. These students will acquire distinct knowledge, skill, competency and confidence to start this/her own enterprise and can also get good jobs as per their merit.
- The Sericulture courses in third-year have been designed to impart hard core knowledge of the subject to the students. There will not be an exit after 3rd year.
- During the 5th semester, the students will have a study tour/ industry visit of 10-12 days duration, which will be counted as 2 credits (Non-gradial).
- The fourth-year course program have been meticulously designed not only to impart specialized knowledge to the students in the selected major discipline but also to prepare the students to take up either research or employment or entrepreneurship as their future career.
- In order to inculcate the moral and experiential habits in students, research methodology and ethics were also added besides Student READY (Rural and Entrepreneurship Awareness Development Yojana) program which include Rural Agriculture Work Experience program / experiential learning/internship and student projects.
- Students will have two choices in fourth year for the award of degree program after successful completion of 40 credits in 7th and 8th semesters Leading to B. Sc. (Hons) Sericulture.
- 7th Semester Options: Hons. Degree Program: 7th Semester of 20 Credits.
- Students opting for the degree leading to B.Sc. (Hons) Sericulture, will study Electives as major /minors. There will be adequate choice of electives/ specialization courses for the students in 7th semester. The students can choose major/ minor courses from the list of courses offered by the university in the related disciplines.
- Students who are undertaking Research in 4th year, will have a different option that is research project-based options listed under choice of electives, major/minors.
- 8th Semester Options: Hons. Degree Program: 8th Semester of 20 Credits
- Students will be offered any of the following options which are discipline specific.

For B.Sc. (Hons) Degree	Student READY (RAWE/Industrial Attachment/Experiential Learning/Hands on Training/Project Work)/ Internship	20 Credits

- After satisfactory completion of fourth year course requirements, the student will become eligible for the award of Degree in BSc. Sericulture (Hons).
- The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.
- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.
- Minimum credits for minor is 32 as per UGC guidelines under "Curriculum and credit framework for undergraduate programs 2022". Minor stream courses can be from the third 300 or above level and 50% of the total credits from minors must be secured in the relevant subject/discipline and another 50% of the total credits from a minor can be earned from any discipline as per students' choice.
- 6th Deans" committee recommends minimum of 173 credits for completion of UG program , excluding 10 credit hours kept for work (MOOCS) at the discretion of students. However, the number of credits can vary in different disciplines.
- The students will also have choice to take 10 credits of online courses either from MOOC/ Swayam/ NPTEL/ mooKIT/ edX/ Coursera or any other portal accepted by the University during the third and fourth year as a partial requirement for the degree of B.Sc. Sericulture (Hons.) or B.Sc. Sericulture (Research).
- ***MOOCS, SWAYAM, student will make his/her own planning and execution under intimation to the Dean/ authority. Students can also select any of the listed courses given under 3.1.12 depending upon the regional priority and infrastructural facility in the concerned university/HEI.
- The online courses may relate with the main discipline or from any other discipline like social science, psychology, anthropology, economics, business management, agriculture, language/ humanity, music, etc. The objective is to allow the students to groom their passion and strengthen their knowledge and competency based on his/her choice.
- These online courses will be non-gradial and a separate certificate would be issued by the Institute/University offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- At each stage of exit (UG-Certificate/ UG-Diploma/ B. Sc./ B.Sc. (Hons.) Sericulture), the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own consultancy/ enterprise.
- The social skills acquired by the students will also make the students more empathetic towards the society and social issues.
- It is recommended that each HEI appoints a Coordinator for INTERNSHIP PROGRAM . The coordinator must plan / monitor internship programe implementation in the university, as per detailed guidelines prescribed by UGC. Read more details of guidelines in UGC notification on Internship, 2023.

Entry and Exit Options

The entry and exit options for the UG Program in Sericulture are shown in the Fig. 1.

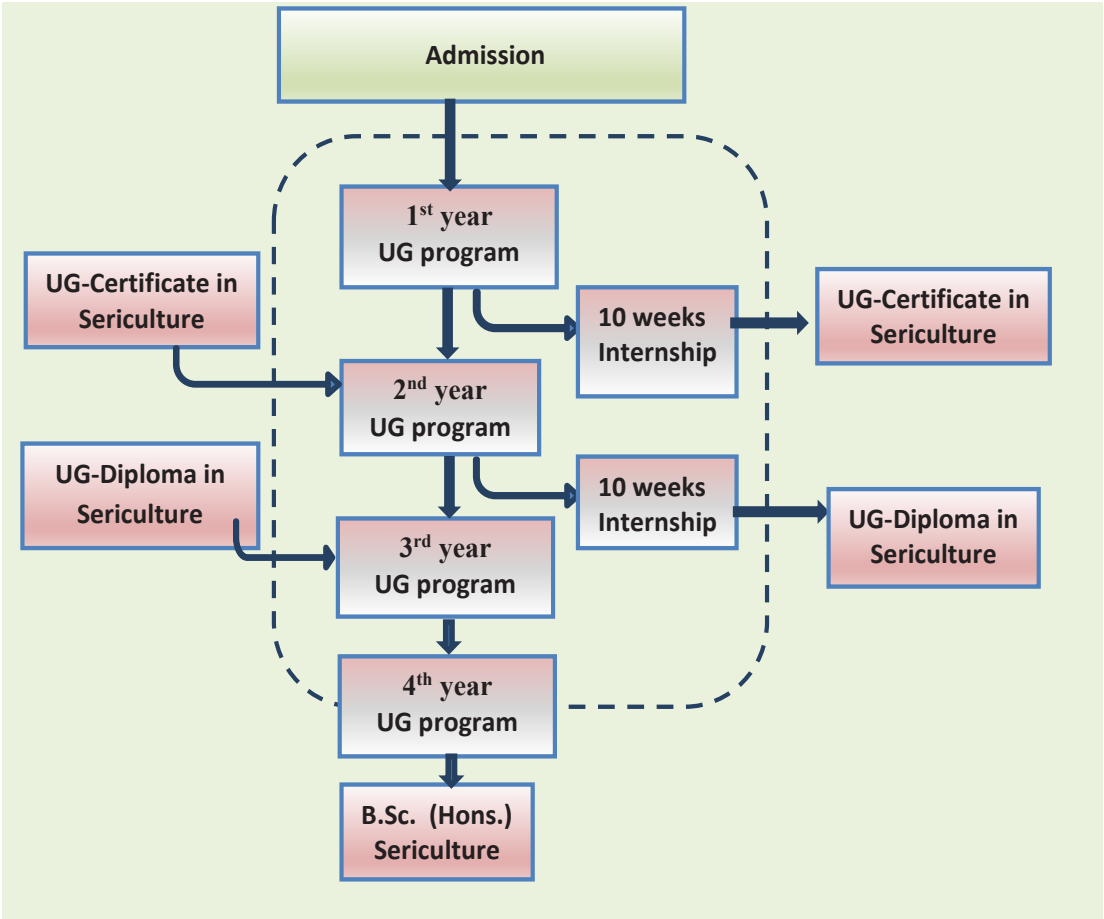

Fig. 1. Entry and Exit options in UG Program in Sericulture

Exit Options

1. UG-Certificate in Sericulture (exit after first year and completion of 10 weeks' internship)

- UG-Diploma in Sericulture (exit after second year and completion of 10 weeks' internship)
- B.Sc. (Hons.) Sericulture (on successful completion of four-year degree requirements)

The Universities may also consider allowing lateral entry for the candidates having Diploma in Sericulture from Polytechnic colleges or other institutions approved by UGC/ICAR as per the provisions to be notified by the respective AU from time to time.

ACADEMIC PROGRAM

Semester wise course distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	I Semester		
1.	Deeksharambh (Induction-cum-Foundation Program) (2 weeks)	2(0+2) Non-gradial	**22 (11+11)**
2.	Leaf Production Technology of Host Plants of Silkworms	3 (2+1)	
3.	Silkworm Seed Production Technology	3 (2+1)	
4.	Mulberry Silkworm Rearing Technology	3 (2+1)	
5.	Raw Silk Production Technology	3 (2+1)	
6.	Farming Based Livelihood System	3 (2+1)	
7.	National Cadet Corps (NCC-I)/National Service Scheme (NSS-I)	1 (0+1)	
8.	Communication Skills	2 (1+1)	
9.	SEC 1: Skill for Employment and Entrepreneurship Development*	4 (0+4)	
	II Semester		
1.	Diseases of Silkworm and their Management	3 (2+1)	**23 (11+12)**
2.	Pests of Host Plants of Silkworms and their Management	2 (1+1)	
3.	Pests of Silkworm and their Management	3 (2+1)	
4.	Bivoltine Silkworm Rearing	2 (1+1)	
5.	Personality Development	2 (1+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	National Cadet Corps (NCC-II)/National Service Scheme (NSS-II)	1 (0+1)	
8.	Entrepreneurship Development and Business Management	3 (2+1)	
9.	SEC 2: Entrepreneurship Development/Skill Enhancement Course*	4 (0+4)	
Post-Semester II (Only For exit option for award of UG-Certificate in Sericulture)			
	Internship (10 weeks)	10 (0+10)	
	Second Year		
	III Semester		
1.	History, Development and Organization of Sericulture Industry	1(1+0)	**21 (13+8)**
2.	Botany and Cytology of Host Plants of Silkworm	3 (2+1)	
3.	Genetics and Breeding of Host Plants of Silkworms	3 (2+1)	
4.	Cytology and Genetics of Silkworm	2 (2+0)	
5.	Fundamentals of Entomology and Nematology	3 (2+1)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
6.	Fundamentals of Genetics	2 (1+1)	
7.	Fundamentals of Agronomy	3 (2+1)	
8.	Physical Education, First Aid and Yoga Practices	2 (1+1)	
9.	SEC 3: Skill for Employment and Entrepreneurship Development/Skill Enhancement Course***	2 (0+2)	
	IV Semester		
1.	Morphology and Systematics of Silkworm	3 (2+1)	**18 (10+8)**
2.	Silkworm Anatomy and Physiology	3 (2+1)	
3.	Water Management	2 (1+1)	
4.	Agriculture Statistics	2 (1+1)	
5.	Agricultural Marketing and Trade	3 (2+1)	
6.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
7.	SEC 4: Skill for Employment and Entrepreneurship Development	2 (0+2)	
Post-Semester IV* (Only For exit option for UG-Diploma in Sericulture)			
1.	Internship (10 weeks)	10 (0+10)	
	Third Year		
	V Semester		
1.	Silkworm Breeding	3 (2+1)	**22 (13+9)**
2.	Vanya Sericulture	2 (1+1)	
3.	Fundamentals of Soil Science	2 (1+1)	
4.	Fundamental of Extension Education	3 (2+1)	
5.	Mechanization in Sericulture	2 (1+1)	
6.	Seri Biotechnology	2 (1+1)	
7.	Physics and Chemistry of Fibres	2 (2+0)	
8.	Fundamentals of Crop Physiology	2 (1+1)	
9.	Introduction to Agrometeorology	2 (1+1)	
10.	Essentials of Plant Biochemistry	2 (1+1)	
11.	Educational and Study tour (2 weeks)	0+2 Non-gradial	
	VI Semester		
1.	Experimental Techniques in Sericulture Research	2 (1+1)	**21 (12+9)**
2.	Silk Throwing Dyeing and Weaving	3 (2+1)	
3.	Spun Silk Technology	1 (0+1)	
4.	Apparels in Sericulture Industry	1 (0+1)	
5.	Agricultural Marketing, Trade and Prices	2 (1+1)	
6.	Introduction to Agro Forestry	2 (1+1)	
7.	Bio Formulation and Nano Technology	2 (1+1)	
8.	Renewable Energy in Agriculture and Allied Sector	3 (2+1)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
9.	Fundamentals of Agricultural Economics	2 (2+0)	
10.	Fundamentals of Plant Pathology	3 (2+1)	
Fourth Year			
VII Semester			
Elective subject***			
Elective - I Host Plant Production Technology	Techniques in Host Plants Improvement	5 (2+3)	**20**
	Techniques in Host Plants Production	5 (2+3)	
	Techniques in Host Plants Protection	5 (2+3)	
	Value Addition to Host Plants By products	5 (2+3)	
Elective - II Cocoon Crop Production Technology	Techniques in Silkworm Crop Improvement	5 (2+3)	**20**
	Techniques in Silkworm Cocoon Production	5 (2+3)	
	Techniques in Silkworm Crop Protection	5 (2+3)	
	Value Addition to Silkworm Rearing By products	5 (2+3)	
Elective - III Silk Product Science Technology	Techniques in Raw Silk Production	5 (2+3)	**20**
	Techniques in Spun Silk Technology	5 (2+3)	
	Techniques in Post Reeling Technology	5 (2+3)	
	Value Addition of Silk Industry By-products	5 (2+3)	
VIII Semester			
I.	Student READY Program (RAWE/in-plant training/ Industrial Attachment/ Experiential Learning/ Hands on Training/Project Work)	20 (0+20)	**20**

*From the basket of available SEC-I modules

**From the basket of available SEC-II modules

***From the basket of available SEC-III modules

****From the basket of available SEC-IV modules

***** The student will take anyone elective as per choice

Skill Enhancement Courses (SEC)

Sl. No	SEC	Course Title	Credit Hours
1.	**SEC-I**	Mulberry Leaf Production Technology	4 (0+4)
2.		Silkworm Egg Production Technology	4 (0+4)
3.	**SEC-II**	Silkworm Rearing Technology	4 (0+4)
4.		Silk Reeling Technology	4 (0+4)
5.	**SEC-III**	Raw Silk Processing	2 (0+2)
6.		Weaving Technology	2 (0+2)
7.		Seri Clinic	2 (0+2)
8.	**SEC-IV**	Value Addition in Sericulture	2 (0+2)
9.		Entrepreneurship and Business Development in Sericulture	2 (0+2)

Department/section wise course breakup

Sl. No.	Course Title	Credit Hours	Total
	Core courses (major and minor)		
1	Leaf Production Technology of Host Plants of Silkworms	3 (2+1)	92 (57+35)
2	Silkworm Seed Production Technology	3 (2+1)	
3	Mulberry Silkworm Rearing Technology	3 (2+1)	
4	Raw Silk Production Technology	3 (2+1)	
5	Diseases of Silkworms and their Management	3 (2+1)	
6	Pests of Host Plants of Silkworms and their Management	2 (1+1)	
7	Pests of Silkworm and their Management	3 (2+1)	
8	Bivoltine Silkworm Rearing	2 (1+1)	
9	History, Development and Organization of Sericulture Industry Govt. Scheme in sericulture III	1(1+0)	
10	Botany and Cytology of Host Plants of Silkworm	3 (2+1)	
11	Genetics and Breeding of Host Plants of Silkworms	3 (2+1)	
12	Cytology and Genetics of Silkworm	2 (2+0)	
13	Fundamentals of Entomology and Nematology	3 (2+1)	
14	Fundamentals of Genetics	2 (1+1)	
15	Fundamentals of Agronomy	3 (2+1)	
16	Morphology and Systematics of Silkworm	3 (2+1)	
17	Silkworm Anatomy and Physiology	3 (2+1)	
18	Water Management	2 (1+1)	
19	Agriculture Statistics	2 (1+1)	
20	Silkworm Breeding	3 (2+1)	
21	Vanya Sericulture	2 (1+1)	
22	Fundamentals of Soil Science	2 (1+1)	
23	Fundamental of Extension Education	3 (2+1)	
24	Mechanization in Sericulture	2 (1+1)	
25	Seri Biotechnology	2 (1+1)	
26	Physics and Chemistry of Fibres	2 (2+0)	
27	Fundamentals of Crop Physiology	2 (1+1)	
28	Introduction to Agrometeorology	2 (1+1)	
29	Essentials of Plant Biochemistry	2 (1+1)	
30	Experimental Techniques in Sericulture Research VI	2 (1+1)	
31	Silk Throwing Dyeing and Weaving VI	3 (2+1)	
32	Spun Silk Technology VI	1 (0+1)	
33	Apparels in Sericulture Industry VI	1 (0+1)	
34	Agricultural Marketing, Trade and Prices VI	2 (1+1)	
35	Introduction to Agro Forestry VI	2 (1+1)	
36	Bio Formulation and Nano Technology VI	2 (1+1)	

37	Renewable Energy in Agriculture and Allied Sector VI	3 (2+1)	
38	Fundamentals of Agricultural Economics	2 (2+0)	
39	Fundamentals of Plant Pathology	3 (2+1)	
Foundation courses/ Ability Enhancement Courses, etc.			
1.	Deeksharambh	2 (0+2) (NG)*	23(13+10)
2.	Farming Based Livelihood System	3 (2+1)	
3.	Communication Skills	2 (1+1)	
4.	Personality Development	2 (1+1)	
5.	Environmental Studies and Disaster Management	3 (2+1)	
6.	Entrepreneurship Development and Business Management	3 (2+1)	
7.	Agricultural Marketing and Trade	3 (2+1)	
8.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9.	Physical Education, First Aid and Yoga Practice	2 (1+1)	
10.	NSS/ NCC - I	1(0+1)	
11.	NSS/ NCC - II	2(0+2)	
12.	Educational Tour	(0+2) NG*	
Elective courses			
1.	Elective Course-I	20(8+12)	20(8+12)
2.	Elective Course-II		
3.	Elective Course-III		
Skill Enhancement Courses			
1.	Skill Enhancement Course I	4 (0+4)	12(0+12)
2.	Skill Enhancement Course II	4 (0+4)	
3.	Skill Enhancement Course III	2 (0+2)	
4.	Skill Enhancement Course IV	2 (0+2)	
In-plant training/ Internship			
1.	Internship only for exit option with UG-Certificate	10 (0+10)*	20 (0+20)
2.	Internship only for exit option with UG-Diploma	10 (0+10)*	
Project Work/ Internship			
1.	Student READY (RAWE/ Industrial Attachment/ Experiential Learning/Hand on Training/Project Work)/ Internship **Experiential Learning** **RAWE** **IPT/Industrial Attachment** **Student Project**	20 (0+20) 8 6 4 2	20 (0+20)
On-line courses			
1.	Online course	10(0+10)*	10(0+10)
			167+4+10

1.	**Department of Host Plant Production**	
S. No.	**Course Title**	**Credit hours**
1	Leaf Production Technology of Host Plants of Silkworms	3 (2+1)
2	Pests of Host Plants of Silkworm and Their Management	2 (1+1)
3	Mechanization in Sericulture	2 (1+1)
4	Experimental Techniques in Sericulture Research	2 (1+1)
	Elective Courses	
5	Techniques in Host Plants Production	5 (2+3)
6	Techniques in Host Plants Protection	5 (2+3)
7	Value Addition to Host Plants By products	5 (2+3)
	Skill Enhancement Courses	
8	Mulberry Leaf Production Technology	4 (0+4)
9	Silkworm Egg Production Technology	4 (0+4)

2.	**Department of Sericulture Crop Improvement**	
S. No.	**Course Title**	**Credit hours**
1	Botany and Cytology of Host Plants of Silkworms	3 (2+1)
2	Genetics and Breeding of Host Plants of Silkworms	3 (2+1)
3	Cytology and Genetics of Silkworms	2 (2+0)
4	Silkworm Breeding	3 (2+1)
5	Seri Biotechnology	2 (1+1)
	Elective Courses	
6	Techniques in Host Plants Improvement	5 (2+3)
7	Techniques in Silkworm Crop Improvement	5 (2+3)

3.	**Department of Cocoon Crop Production**	
S. No.	**Course Title**	**Credit hours**
1	Silkworm Seed Production Technology	3 (2+1)
2	Mulberry Silkworm Rearing Technology	3 (2+1)
3	Diseases of Silkworm and Their Management	3 (2+1)
4	Pests of Silkworm and their Management	3 (2+1)
5	Bivoltine Silkworm Rearing	2 (1+1)
6	History, Development and Organization of Sericulture Industry	1 (1+0)
7	Morphology and Systematics of Silkworm	3 (2+1)
8	Silkworm Anatomy and Physiology	3 (2+1)
9	Vanya Sericulture	2 (1+1)
	Elective Courses	
10	Techniques in Silkworm Cocoon Production	5 (2+3)
11	Techniques in Silkworm Crop Protection	5 (2+3)

S. No.	Course Title	Credit hours
12	Value Addition to Silkworm Rearing By products	5 (2+3)
	Skill Enhancement Courses	
13	Silkworm Rearing Technology	4 (0+4)
14	Seri Clinic	2 (0+2)
15	Value Addition in Sericulture	2 (0+2)
16	Entrepreneurship and Business Development in Sericulture	2 (0+2)

4.	Department of Silk Product Science	
S. No.	**Course Title**	**Credit hours**
1	Raw Silk Production Technology	3 (2+1)
2	Physics and Chemistry of Fibres	2 (2+0)
3	Silk Throwing Dyeing and Weaving	3 (2+1)
4	Spun Silk Technology	1 (0+1)
5	Apparels in Sericulture Industry	1(0+1)
	Elective Courses	
6	Techniques in Raw Silk Production	5 (2+3)
7	Techniques in Spun Silk Technology	5 (2+3)
8	Techniques in Post Reeling Technology	5 (2+3)
9	Value Addition of Silk Industry By-products	5 (2+3)
	Skill Enhancement Courses	
10	Silk Reeling Technology	4 (0+4)
11	Raw Silk Processing	2 (0+2)
12	Weaving Technology	2 (0+2)

Year wise List of Courses for Certificate, Diploma, Degree
I Department of Host Plant Production

Program	Course Title	Credit Hours	Year wise Credit
I semester	Leaf Production Technology of Host Plant of Silkworms	3 (2+1)	5
II semester	Pests of Host Plants of Silkworm and theirManagement	2 (1+1)	
III semester	-	-	-
IV semester	-	-	
V semester	Mechanization in Sericulture	2 (1+1)	4
VI semester	Experimental Techniques in Sericulture Research	2 (1+1)	
VII semester	Techniques in Host Plants Production	5 (2+3)	15
	Techniques in Host Plants Protection	5 (2+3)	
	Value Addition to Host Plants By products	5 (2+3)	
	Total	**24(11+13)**	**24**
VIII semester	**Project Work / Internship (10 credit each)**	**20(0+20)**	**20**

Year wise List of Courses for Certificate, Diploma, Degree
II Department of Sericulture Crop Improvement

Program	Course Title	Credit Hours	Year Wise Credit
I semester	-		
II semester	-		
III semester	Botany and Cytology of Host Plants of Silkworm	3 (2+1)	8
	Genetics and Breeding of Host Plants of Silkworms	3 (2+1)	
	Cytology and Genetics of Silkworms	2 (2+0)	
IV semester			
V semester	Silkworm Breeding	3 (2+1)	5
	Seri Biotechnology	2 (1+1)	
VI semester			
VII semester	Techniques in Host Plants Improvement	5 (2+3)	10
	Techniques in Silkworm Crop Improvement	5 (2+3)	
	Total	**23 (13+10)**	**23**
VIII semester	**Project Work / Internship (10 credit each)**	**20 (0+20)**	**20**

Year wise List of Courses for Certificate, Diploma, Degree
III Department of Cocoon Crop Production

Program	Course Title	Credit Hours	Year Wise Credit
I semester	Silkworm Seed Production Technology	3 (2+1)	14
	Mulberry Silkworm Rearing Technology	3 (2+1)	
II Semester	Diseases of Silkworm and Their Management	3 (2+1)	
	Pests of Silkworm and their Management	3 (2+1)	
	Bivoltine Silkworm Rearing	2 (1+1)	
III semester	History, Development and Organization of Sericulture Industry	1 (1+0)	7
IV semester	Morphology and Systematics of Silkworm	3 (2+1)	
	Silkworm Anatomy and Physiology	3 (2+1)	
V Semester	Vanya Sericulture	2 (1+1)	2
VI semester	-	-	
VII Semester	Techniques in Silkworm Cocoon Production	5 (2+3)	15
	Techniques in Silkworm Crop Protection	5 (2+3)	
	Value Addition to Silkworm Rearing By products	5 (2+3)	
	Total	**38 (21+17)**	**38**
VIII Semester	**Project Work / Internship (10 credit each)**	**20 (0+20)**	**20**

Year wise List of Courses for Certificate, Diploma, Degree
IV Department of Silk Product Science

Program	Course Title	Credit Hours	Year Wise Credit
I semester	Raw Silk Production Technology	3 (2+1)	3
II semester	-		
III semester	-		-
IV semester	-		
V semester	Physics and Chemistry of Fibres	2 (2+0)	7
VI semester	Silk Throwing Dyeing and Weaving	3 (2+1)	
	Spun Silk Technology	1 (0+1)	
	Apparels in Sericulture Industry	1 (0+1)	
VII semester	Techniques in Raw Silk Production	5 (2+3)	20
	Techniques in Spun Silk Technology	5 (2+3)	
	Techniques in Post Reeling Technology	5 (2+3)	
	Value Addition of Silk Industry By-products	5 (2+3)	
	Total	**30 (14+16)**	**30**
VIII semester	**Project Work / Internship (10credit each)**	**20 (0+20)**	**20**

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits hours
Core Courses (Minor and Major)	:	112
Skill Enhancement Courses	:	12
Multidisciplinary/Common Courses (MDC, VAC and AEC)	:	23
Internship/ In-plant training (Student READY)	:	20
Online courses/ MOOC (non – gradial) *	:	10
Total	:	**167+10***

Credits Allocation Scheme of UG Sericulture Programs (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	$3^{(2)}$		$1^{(3)} + 2^{(4)}$	4	-	22	$2^{(1)}$		
II	10	$3^{(5)}$	$3^{(6)}$	$1^{(3)} + 2^{(7)}$	4	-	23	-	$10^{(12)}$	
III	17	----		$2^{(8)}$	2	-	21			
IV	10	$3^{(9)}$	$3^{(10)}$	----	2	-	18	-	$10^{(13)}$	**10**
V	22	-	-	-	-	-	22	$2^{(11)}$		
VI	21	-	-	-	-	-	21	-		
VII	20	-	-	-	-	-	20	-		

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(2) Farming based Livelihood systems
(3) NCC/NSS/NSO; (4) Communication Skills; (5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management;
(7) Personality Development; (8) Physical Education, First Aid and Yoga Practices
(9) Agriculture Marketing and Trade; (10) Agricultural Informatics and Artificial Intelligence
(11) Study tour (10-14 days).
(12) Only for those opting for an exit with UG-Certificate (13) Only for those opting for an exit with UG-Diploma

DETAILED SYLLABI

	First Year	
	SEMESTER-I	
Sl. No.	**Course Title**	**Credit Hours**
	Deeksharambh (Induction-cum-Foundation Program) (2 weeks)	2 (0+2) Non-gradial
SHP 111	Leaf Production Technology of Host Plants of Silkworms	3 (2+1)
SCP111	Silkworm Seed Production Technology	3 (2+1)
SCP112	Mulberry Silkworm Rearing Technology	3 (2+1)
SPS 111	Raw Silk Production Technology	3 (2+1)
MDC111	Farming Based Livelihood System	3 (2+1)
NSS/NCC 111	NCC/NSS	1 (0+1)
AEC 111	Communication Skills	2 (1+1)
SEC 111/112	SEC 1: Skill for Employment and Entrepreneurship Development	4 (0+4)
	Total	**22 (11+11)**

*From the basket of available SEC-I modules

Indicative options for SEC– I** (any one module to be selected)

Sl. No.	Course Title	Credit Hours
	Module, SEC-1	
SEC 111	Mulberry Leaf Production Technology	4 (0+4)
SEC 112	Silkworm Egg Production Technology	4 (0+4)

**The universities/ institutes are free to include other options for SEC as per the local needs and facilities available, also to interchange the modules in between semesters. The modules can be taken in campus or off-campus.

SEMESTER-I

***Deeksharambh* (Induction-cum-Foundation Program) 2 (0+2) (NG)**

The activities to be taken under "Deeksharambh" shall aim at creating a platform for students to

- Help for cultural Integration of students from different backgrounds,
- Know about the operational framework of academic process in university,
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

I. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
II. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
III. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
IV. Activities to enhance cultural Integration of students from different backgrounds
V. Field visits to related fields/ establishments
VI. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Leaf Production Technology of Host Plants of Silkworms 3 (2+1)

Objective

- To understand the cultivation practices of host plants of mulberry, tasar, eri and muga silkworms

Theory

Introduction, climatic requirements, sexual and asexual methods of propagation, mulberry varieties, nursery techniques in mulberry propagation, pruning, irrigation schedules. Green manuring, manurial and fertilizer schedules. Weed control practices. Harvesting under different planting system of mulberry. Leaf preservation. Mulberry cultivation under rainfed condition and irrigated condition. Tree mulberry plantation, precision farming in mulberry and chawki / young age mulberry plantation. Cultivation and propogation of host plants of eri silkworms: castor, tapioca and kesaru. Cultivation and propogation of host plants of tropical tasar silkworms: Asan, Arjun and sal. Temperate tasar / oak tasar silkworms: *Quercus serrata* and *Quercus incana*. Cultivation and propogation of host plants of muga silkworms - som and soalu.

Practical

Study of primary and secondary tillage implements, soil sampling technique. Nursery bed preparation and raising of seedling through sexual propogation and saplings through asexual propogation in mulberry. Identification of mulberry varieties. Manures and fertilizer application. Planting methods. Irrigation methods, pruning methods, weed management. Harvesting and preservation of mulberry leaves. Identification of host plants of Eri silkworm, host plants of tasar silkworms and host plants of muga silkworms. Cultivation of primary host plants of eri silkworms. Cultivation of primary host plants of tasar silkworms and cultivation of secondary host plants of muga silkworms. Herbarium preparation for the host plants and weeds. Collection of insect pests of host plants and disease specimens of host plants.

Suggested readings

1. Rangaswami, G. and Manjeet S. Jolly, E-manual 1- Mulberry Cultivation, FAO, Rome, p. 149.
2. Anonymous, 2007, Tasar culture – Principles and Practices, Vol.1. Tasar silkworm host plants – Production, Protection and improvement. N. Suryanarayana (Chief ed.), S. K. Gangawar, R. Kumar and A. K. Srivastava (eds.). CTRTI, Piska Nagari, Ranchi. p. 266
3. Anonymous, 2003, Sericulture Buisness manual – A user's guide. Vol. 1.
4. Ganga, G. and Sulochanachetty, J., Introduction to sericulture.
5. Minamizawa, K., 1997, Moriculture, Science of Mulberry Cultivation. Oxford and IBH Publishing Co. Pvt. Ltd. p 235-285.

Silkworm Seed Production Technology 3 (2+1)

Objective

- To study the importance of quality silkworm seed production and silkworm seed production organization structure in sericulture industry

Theory

Importance of quality silkworm seed in sericultural industry. Embryology of *Bombyx mori*, *Samia ricini, Antheraea assamensis* and *Antheraea mylitta*. Morphological and biochemical changes in eggs of different silkworms during embryogenesis. Seed areas, special features of seed areas and seed cocoon transaction. Seed organization in India and abroad. Three tier system of egg production (P3, P2 and P1). Special features of parental silkworm rearing, Basic seed and Industrial seed and standards for the same. Hill amelioration, marketing of seed cocoons, grainage techniques and steps in hybrid DFL preparation. Small scale production of hibernating and non-hibernating eggs in loose form and on egg sheets. Methods of termination of hibernation, acid treatment for hibernating eggs. Egg borne diseases and methods of elimination. Pebrine disease management at various levels. Incubation and preservation of DFLs till disposal. Standards for quality eggs. Preservation and handling of eggs, different hibernation schedules. Cost structure of a model grainage and a private grainage. Economics of egg production, cost of production. Management of industrial grainages. Maintenance of records in grainages. Enumeration of seed legislation act.

Practical

Methods of embryo testing and preparation of permanent slides**.** Grainage plan and equipments, different grainage operations. Procurement, transportation and preservation of seed cocoons. Sexing,

moth emergence, pairing, depairing, preparation of eggs on cards and in loose forms. Identification of good, dead, unfertile and hibernated eggs. Mother moth examination, disinfection of eggs. Acid treatment for hibernating eggs. Preparation of hybrid eggs. Visit to local grainages.

Suggested Readings

1. Manual on Silkworm Egg Production - Narasimhanna M N (1998). Central Silk Board . Bengaluru.
2. Silkworm Seed Production - Jayant Jayaswal, K. Giridhar, J. Somi Reddy, H. Jagadish Prabhu (2008). Central Silk Board. Bengaluru.
3. Silkworm Egg Science - Tribhuwan Singh, Madan Mohan Bhat, Mohammad Ashraf Khan (2010). Daya Publishing House. Delhi.

Mulberry Silkworm Rearing Technology 3 (2+1)

Objective

- To improve quality and quantity of cocoon production through induction of modern rearing technology in Sericulture.

Theory

1. Introduction: sericulture, components and importance of sericulture
2. Morphology and biology of silkworm *Bombyx mori*
3. Classification of silkworm races
4. Characters of races of silkworm
5. Planning of silkworm rearing
6. Different types of silkworm rearing houses
7. Silkworm rearing appliances
8. Disinfection
9. Egg incubation and methods
10. Brushing and types of brushing
11. Environmental requirements for different stages of silkworm
12. Rearing methods of young age and late age silkworm
13. Chawki Rearing Centres (CRC) and their management
14. Feeding of silkworm
15. Bed cleaning and methods of bed cleaning
16. Spacing management during silkworm rearing
17. Moulting (Ecdysis) care
18. Mounting of silkworms and mountages
19. Quality cocoon harvest and assessment of cocoons quality
20. Nutritional requirement of silkworm *Bombyx mori*
21. Role of artificial diet for Chawki rearing

22. Importance of juvenile hormone analogues in practical sericulture
23. Diseases and pests of silkworm and their management
24. Maintenance of rearing records

Practical

1. Life cycle of silkworm *Bombyx mori*
2. Study of plan for rearing house- chawki and late-age silkworm rearing house
3. Study of different rearing equipment/appliances
4. Disinfectants and their applications
5. Study of egg incubation methods and black boxing
6. Study of brushing of silkworms and selection of leaf for different instars
7. Study of bed cleaning methods and moulting worms and management
8. Study of different types of chawki and late-age silkworm rearing methods
9. Study of shoot feeding method and shelf rearing method
10. Role of environmental factors, micro and macro-nutrients on growth and development of silkworms
11. Identification of ripe worms and methods of mounting
12. Study of fortification of mulberry leaves and artificial diet in silkworm rearing
13. Study of use of juvenile hormone analogues on silkworm rearing
14. Harvesting of cocoons, transportation and marketing of cocoons
15. Study of natural enemies of silkworms
16. Study on maintenance of rearing records
17. Visit to Chawki Rearing Centers
18. Visit to farmer's mulberry garden, rearing house and cocoon market

Suggested Readings

1. Handbook of sericulture technologies (CSB) – Dr S. B. Dandin and Dr K. Giridhar.
2. An introduction to sericulture – G. Ganga and Sulochanachetty.
3. FAO manual on sericulture (Vol II) – Silkworm Rearing
4. Silkworm crop protection – Dr B. Nataraju, Dr K. Sathyprakash, Dr D. Manjunath and Mr. C. Aswani Kumar.
5. Intensive bivoltine sericulture technology package: CSR and TI Mysore.

Raw Silk Production Technology 3 (2+1)

Objectives

1. To understand the processing of cocoon for reeling a silk yarn
2. To acquaint with the skills of cocoon reeling and raw silk production

Theory

Introduction - world raw silk production and present silk production in India, cocoon formation, physical characteristics of mulberry cocoon- colour, shape, wrinkles etc. Cocoon

markets - its functions, method of transaction, method of fixing the cocoon price. Transportation of cocoons-care and handling. Cocoon testing and grading. Cocoon sorting - manual and mechanical method. Different types of defective cocoons. Mulberry silk reeling process - steps involved in silk reeling, cocoon stifling and methods, storage of stifled cocoons - sun drying, steam stifling, hot air drying. Cocoon cooking and its systems - open pan, two pan, three pan, pressurized cooking method/circular cocoon boiling machine, mechanical cooking, brushing methods. Evolution of reeling machines. General principles in reeling, different reeling machines - charakha, improved charakha, cottage basin/domestic basin, multiend reeling machine, semi automatic and automatic reeling machine. Re-reeling and lacing, silk examination, skeining, book and bale making, storage and selling raw silk, silk exchange. Physical properties of Tasar, Muga, eri cocoon. Tasar cocoon reeling - stifling, cooking, reeling machines. Muga cocoon reeling - stifling, cooking, reeling machines. Eri cocoon cooking, spinning methods, Filature water engineering. Marketing of silk, silk exchanges and price stabilization of silk. Objectives and advantages of raw silk testing and grading. Qualities of silk, major and minor characters of quality silk, equipments and facilities required for silk testing, silk testing and conditioning houses, BIS and ISA specifications of testing and grading of silk, condition test, winding test, size test, strength test, evenness, cleanness and neatness tests, cohesion test, standard tables for grading of silk.

Practical

1. Cocoon testing – tactile and mechanical tests
2. Fixing up of cocoon price based on the test results
3. Cocoon sorting – manual and identification of different defective cocoons and working out the defective cocoon per cent and deciding the cocoon price
4. Steam generation units - Boilers
5. Cocoon stifling by steam and hot air oven method and conditioning for reeling
6. Cooking and brushing of steam stifled cocoons – open pan method
7. Cocoon reeling in multiend reeling machine
8. Croissure formation and reeling path
9. Putting the knot for the broken yarn
10. Casting of brushed cocoons to the end
11. Maintaining the continous reeling speed
12. Reeling of cocoons (crossreed and bivoltine)
13. Reel permeation by soaking method
14. Re-reeling in closed type re-reeling machine
15. Lacing of re-reeled silk
16. Examination of re-reeled silk yarn and small skein making using skeining machine
17. Book and bale making and submission of skein
18. Marketing of reeled raw silk in silk exchange

Suggested Readings

1. Anonymous, 2003, Seri Business Manual. CSB.

2. Anonymous, 2003, Vanya silks, CSB.
3. Krishnaswami, S., Madhava Rao, N.R., Suryanarayan, S.K. and Sundaramurthy, T.S., 1972, Sericulture Manual 3 - Silk Reeling. FAO, Rome. p.112.
4. Mahadevappa, V. G. Haliyal, D.G. Shankar and Ravindra Bhandiwad, Mulberry silk reeling technology.
5. Tammanna N. Sonuwalker, Handbook of silk technology.
6. Yong-woo Lee, Silk reeling and testing manual. National Sericulture and Entomology Institute, Seoul, Republic of Korea.

Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood - Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework. Definition of farming systems and farming based livelihood systems. Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming based livelihood systems - Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aquaculture, Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc. Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming based livelihood models by NABARD, ICAR and other organizations across the country. Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming based livelihood opportunities. Role of farming based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models. Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models). Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis. Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A Strategy for Environmentally, Sound and Participatory Rural Development. Center for Science and Environment, New Delhi, India
2. Ashley, C. and Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience. Department for International Development, London, UK. Volume 7. [Google Scholar].
3. B.P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K.N. Pathak, A. Hassan, S.K. Singh, K.K. Singh and K.M. Singh. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar. ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna, Bihar.
4. Carloni, A. (2001). Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa. Consultation Document, FAO, Rome, Italy.
5. Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA.
6. Evenson, R.E. (2000). Agricultural Producitivity and Production in Developing Countries'. FAO, The State of Food and Agriculture, FAO, Rome, Italy.
7. Panwar *et al*. (2020). Integrated Farming System Models for Agricultural Diversification, Enhanced Income and employment. Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. (2016). Farming System and Sustainable Agriculture. Kalyani Publishers, New Delhi.
9. Singh, J.P. *et al*. (2015). Region Specific Integrated Farming System Models. ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and U. S., Walia, (2020). Farming System and Sustainable Agriculture. Scientific Publishers, Jodhpur, Rajasthan.

National Cadet Corps (NCC-I) 1 (0+1)

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill - aim, general words of command, attention, stands at ease, stand easy, and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honours, and awards.
- Nation Building - cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) 1 (0+1)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work. To be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

National Service Scheme I: Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS.
- Organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers', awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who are the agents of social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and shramdaan. Indian tradition of volunteerism - its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights, and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Communication Skills 2 (1+1)

Objective

- To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, speaking, reading and writing skills; Precis writing/ Abstracting/Summarizing; Style of technical communication; Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; Phrases and clauses; Case: subjective case, possessive case, objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; Vocabulary building exercises; Interview Techniques; Organization of events.

Suggested readings

1. Allport G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication: A Contextual Approach. Houghton Mifflin Co, Boston.
7. Pease Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University Press.

SEC-I

Mulberry Leaf Production Technology **4(0+4)**

Objectives

1. To acquaint with the skills for quality leaf production
2. Maximization of profit in mulberry leaf production

Practicals

1. Identifying characters of mulberry varieties
2. Prepartion of cuttings for raising saplings
3. Raising of mulberry saplings in tubes / polythene bags and in nursery bed by VAM inoculation
4. Raising of Kissan nursery
5. Scheduling of activities for mulberry cultivatin under rainfed condition
6. Scheduling of activities for mulberry cultivation under iirigated condition
7. Observing and recording mulberry growth and yield in different systems of planting – row system, kolar system and Indo-Japanese, 3M plantation
8. Raising mulberry garden exclusively for chawki silkworm rearing
9. Integrated nutrent management- Inorganic fertilizer and application
10. Organic farming – preparation of compost, vermicompost, biofertilizer, bio-organic formaulations - jeevamrutha, panchagavya
11. Enrichment of compost, vermicompost
12. Application of foliar spray in mulberry – nutrient, triacontanol, seriboost
13. Weed and their management – mechanical control, tillage, hoeing, digging, mulching, chemical control, merits and demerits
14. Mechanization of mulberry cultivation and its importance
15. Mulberry based integrated farming system – Features of IFS
16. Mixed farming, intercropping
17. Identification of pests of mulberry and its managment - Foliar, stem, root
18. Identification of diseases of mulberry by the symptoms – Foliar, stem, root
19. Integrated pest and disease management in mulberry
20. Utility of biocontrol agents in mublerry field
21. Maintenance of cultivation sheet and farm records
22. Economics of mulberry leaf production
23. Estimating the brushing capaciity for leaf production

Suggested readings

1. Choudhury P.C. and Giridhar K. 1987, Mulberry cultivation. "Appropriate sericulture techniques". Manjeet S. Jolly (ed.). International Centre for Training and Research Tropical Sericulturis. Manandwadi Road, pp. 18-34.

2. Minamizawa K. 1997. Moriculture, Science of mulberry cultivation. Oxford and IBH Publishing Co. Pvt. Ltd. p 235-285.
3. Rajanna L., Das P.K., Ravindran S., Bogesha K., Mishra R.K., Singhvi N.R., Katiyar, R.S. and Jayaram H. 2005. Mulberry cultivation and physiology. CSB, p 1-206.
4. Rajanna L., Das P.K., Ravidran S., Bhogesha K., Mishra R.K., Singhvi N.R., Katiyar R.S. and Jayaram H., 2005. Mulberry cultivation and physiology, CSB, pp. 1-206.

Silkworm Egg Production Technology 4 (0+4)

Objectives

1. Developing skill Competency of the student in silkworm seed production, quality assessment of seed cocoon and producing DFL's.
2. Developing the technical skill in handling diapause and non-diapause egg.
3. Training the students to detect the defective eggs through predictive test.
4. Building scientific skill in students to produce disease free laying's.

Practical

1. Study of characteristics of important parental breeds of *Bombyx mori* L.
2. Silkworm embryo testing and preparation of slides
3. Study of procurement, transportation and preservation of seed cocoons
4. Study of moth emergence, coupling, decoupling and oviposition
5. Preparation of hibernating eggs and non-hibernating eggs on egg cards
6. Preparation of loose eggs of mulberry silkworm, *Bombyx mori* L.
7. Brine treatment for loose eggs of *Bombyx mori* L.
8. Termination of hibernation in eggs of *Bombyx mori* L. through chemical methods
9. Studyof preliminary examination and mother moth examination for pebrine detection
10. Influence of mating duration on fecundity in *Bombyx mori* L.
11. Effect of re-use of male moths on fecundity and hatching in silkworm
12. Influence of refrigeration of polyvoltine eggs of *Bombyx mori* L. on hatching

Suggested readings

1. Manual on Silkworm Egg Production - Narasimhanna M N (1998). CSB. Bengaluru.
2. Silkworm Seed Production - Jayant Jayaswal, K Giridhar, J Somi Reddy, H Jagadish Prabhu (2008). Central Silk Board. Bengaluru.
3. Silkworm Egg Science - Tribhuwan Singh, Madan Mohan Bhat, Mohammad Ashraf Khan (2010). Daya Publishing House. Delhi.

SEMESTER-II		
Sl. No.	**Course Title**	**Credit Hours**
SCP 121	Diseases of Silkworm and their Management	3 (2+1)
SHP 121	Pests of Host Plants of Silkworms and their Management	2 (1+1)

SEMESTER-II		
Sl. No.	**Course Title**	**Credit Hours**
SCP 122	Pests of Silkworm and their Management	3 (2+1)
SCP 123	Bivoltine Silkworm Rearing	2 (1+1)
AEC 121	Personality Development	2 (1+1)
VAC 121	Environmental Studies and Disaster Management	3 (2+1)
NSS/NCC 121	NSS/NCC	1 (0+1)
MDC 121	Entrepreneurship Development and Business Management	3 (2+1)
SEC 121/122	SEC 2: Entrepreneurship Development/Skill Enhancement Course	4 (0+4)
	Total	**23(11+12)**

*From the basket of available SEC-II modules.

Indicative options for SEC – II* (any one module to be selected)

Sl. No.	Course Title	Credit Hours
	Module-SEC-2	
SEC 121	Silkworm Rearing Technology	4 (0+4)
SEC 122	Silk Reeling Technology	4 (0+4)

*The Universities can develop their own SEC modules considering the local needs and available facilities.

Post-Semester II (Only For exit option for award of UG-Certificate in Sericulture)

S. No.	Course Title	Credit Hours
SCE 121	Internship (10 weeks)	10 (0+10)

Student taking various modules will get a Certificate with Nomenclature as follows-

Nomenclature of Certificate	Module taken	
	Semester-I	Semester-II
UG Certificate in Sericulture	SEC – 1	SEC – 2

Diseases of Silkworm and Their Management 3 (2+1)

Objectives

1. Students needs to be acquiring the skills, knowledge and experiences the management of silkworm diseases.
2. To acquaint the knowledge of silkworm diseases.
3. To formulate and execute the management practices for silkworm diseases according to season.
4. To assess the cocoon crop loss due to silkworm diseases.
5. To mitigate the probable unforeseen risks during silkworm crop period.

Theory

1. Introduction and importance of silkworm diseases
2. Nature and extent of damages caused to sericulture due to biotic and abiotic factors

3. Infectious and non-infectious diseases of silkworms including non-mulberry silkworms
4. Koch's postulates
5. Non-infectious diseases including physical and chemical injuries, nutritional and genetic disorders
6. Important infectious diseases:

   Pebrine – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   Flacheire – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   Muscardines – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   Grasserie (BmNPV) – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   CPV – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   IFV – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.

   DNV – Causal agents, life cycles, incubation periods, symptoms, diagnosis, seasonal factors, epizootiology, prevention and control.
7. Cross infectivity of pathogens to silkworms
8. Impact of insect crop pests on silkworm
9. Impact of biological pest control on sericulture
10. Infectivity techniques
11. Determination of LC50 and ET50
12. Disinfection and hygiene, disinfectants and their mode of action

Practicals

1. Study of gross pathology of different diseases
2. Causal agents of infectious disease and symptoms
3. Isolation and culturing of silkworm pathogens
4. Koch's postulates
5. Preparation of permanent slides
6. Infectivity techniques
7. Cross infectivity
8. Histopathological techniques
9. Patho-physiological techniques
10. Determination of LC_{50} and ET_{50}
11. Effect of different insecticides on silkworms
12. Silkworm breeds and instars susceptibility

13. Preventive measures of infectious diseases
14. Disinfection and hygiene

Suggested readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation volunteers, Japan, P. 594.
2. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P. 376.
3. Dandin, S.B. and Giridhar, 2010, Handbook of Sericulture Technologies. CSB, Bengaluru, P. 427.
4. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P. 176.
5. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P. 429.
6. Govindaiah, Gupta, V.P., Sharma, D.D., Rajadurai, S. and Nishitha Naik, V., 2005, Textbook on Mulberry Crop Protection. Central Silk Board, Bengaluru, P. 247.
7. Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Principles of Silkworm Pathology. Seri Scientific Publishers, P.420.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P. 215.
9. Krishnaswami, S., Narasimhanna, M.N., Suryanarayan, S.K. and Kumararaj, S., 1979, Silkworm Rearing. FAO Manual, Vol. II, FAO, Rome, pp. 99-129.
10. Narayanaswamy, K.C. and Devaiah, M.C., 1998, Silkworm Uzi Fly. Zen Publishers, Bengaluru, P. 232.
11. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection. Central Silk Board, Bengaluru, pp. 1 – 324.
12. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P 42.
13. Ullal, S.R. and Narasimhanna, M.N. 1981, Handbook of Practical Sericulture, Central Silk Board, Bengaluru, P. 209.

Pests of Host Plants of Silkworm and their Management 2 (1+1)

Objectives

1. Students need to acquire the skills, knowledge and experiences on insect pests of host plants of silkworms.
2. To acquaint the knowledge on insect pests of silkworm host plants.
3. To acquaint and enlisting the reasons responsible for insect attack to silkworm hosts.
4. To study management of silkworm host plant pests.
5. To impart skills on production of natural enemies of pests of silkworm host plants.

Theory

1. Definition of pest, Classification of insect pests and status of pest, Causes for pest outbreak

2. Pest residue, Biotic potential, Environmental resistance, Concepts and Principles of crop pest management
3. Insect pest of mulberry (Defoliators and Sucking Pests) and their management
4. Non insect pests of mulberry (Mites, Snails and slugs) and their management
5. Insect pest of *Terminalia* spp., Sal, Som and their management
6. Insect pest of oak and their management
7. Insect pest of ber, castor and their management
8. Definition of pesticide, Classification of insecticides (based on mode of action, Mode of entry, Chemical nature)
9. Formulation, objectives of formulation. Advantages and disadvantages of different formulations
10. Safe period, Safer methods of application of insecticides and and Pesticide residue problems

Practicals

1. Types of damage to plants by different insects, Concept of pest, their classification, reasons for insects assuming pest status
2. Study of defoliating and sucking pests of mulberry
3. Visit to mulberry and non mulberry plots to study the nature and symptoms of pest damage
4. Study of pests of *Terminalia* spp and Sal, *Shorea robusta*
5. Study of pests of Ber, *Zizyphus jujuba*, Oak, Som, and Castor
6. Pesticidal formulations and method of application
7. List of commonly used pesticides and related useful information.

Suggested readings

1. Khan Mohammad Ashraf, Madan Mohan Bhat and Tribhuwan Singh, 2011, Silkworm crop protection. Daya Publishing House, Delhi.
2. R.N. Singh, Dr. Beera Saratchandra, 2001, Sericulture Entomology.
3. R.N. Singh, Dr. M.V.Samson, Dr. R.K. Datta, 2000, Pest management in Sericulture. Indian Publisher and Distributions, Delhi.
4. Sathejadhar, 2012, Sericulture and Pest management.

Journals:

1 Annual Review of Entomology.
2 Journal of Economic Entomology.
3 Journal of Medical Entomology.
4 Environmental Entomology.
5 Medical and Veterinary Entomology.
6 Ecological Entomology.
7 Systematic Entomology.
8 Physiological Entomology.

Online Sources:

- www.cabi.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/

Pests of Silkworm and their Management **3(2+1)**

Objectives

1. Students needs to acquire the skills, knowledge and experiences the management of silkworm pests.
2. To acquaint the knowledge of different silkworm pests.
3. To formulate and execute the management practices for mitigate the silkworm pest infestation.
4. To assess the cocoon crop loss due to silkworm pest infestation.
5. To mitigate the probable unforeseen risks during silkworm crop period.

Theory

1. Introduction, Glossary, Classification minor and major pests
2. Concepts of Pest management, Economic Injury Level (EIL) and Economic threshold level (ETL)
3. Classification of pests based on occurrence, level of infestation, extent of loss and site of preference
4. Importance of silkworm pests including insect and non-insect pests
5. Tachnid fly, Exorista sp. of silkworm: classification, distribution, occurrence, nature of damage and alternative hosts
6. External morphology of different stages of silkworm uzi fly
7. Uzi fly behaviour in relation to emergence, mating, oviposition and flight
8. Uzi fly management through physical and mechanical practices
9. Uzi fly management through chemo-sterilization, biological control and genetic control
10. Uzi fly integrated pest management (IPM) practices
11. Importance of cocoon pests in grainages viz., dermestid beetles, earwigs, ants and mites, their biology and nature of damage
12. Grainage pest management through physical, mechanical and chemical means and integrated management of the pest
13. Occurrence, nature of damage, prevention and control of other pests of silkworm like Pantatomid bug (Canthecons sp.), Praying mantid (Hierodula sp.), Red ant (Oecophylla sp.), Braconid fly (Apantdes sp.)
14. Occurrence and nature of damage caused by non-insect pests like rats, squirrels, lizards, mites, nematodes, snakes, birds, etc.

Practicals

1. Major pests of mulberry silkworm, *Bombyx mori* L.

2. Minor pests of mulberry silkworm, *Bombyx mori* L.
3. Study of life cycle of silkworm uzi fly, *Bombyx mori* L.
4. Estimation of the incidence of uzi fly in silkworm crop
5. Study of management of Indian uzi fly by through physical and mechanical practices
6. Study of management of Indian uzi fly by chemo-sterilization, biological control and genetic control
7. Study of management of Indian uzi fly by use of bio-pesticides
8. Study of biology and management of dermestid beetle
9. Study of biology and management of ants
10. Study of non mulberry silkworms pests and their management
11. Study of non-insect pests like rats, squirrels, lizards, mites, nematodes, snakes, birds, etc.
12. Identification and collection of pests and affected specimens
13. Visit to Seri-agro-ecosystems (farmer's field)
14. Visit to R and D institute
15. Presentations

Suggested Readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation Volunteers, Japan, P. 594.
2. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P. 376.
3. Dandin, S.B. and Giridhar, 2010, Handbook of Sericulture Technologies. CSB, Bengaluru, P. 427.
4. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
5. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P. 429.
6. Govindaiah, Gupta, V.P., Sharma, D.D., Rajadurai, S. and Nishitha Naik, V., 2005, Textbook on Mulberry Crop Protection, Central Silk Board, Bengaluru, P. 247.
7. Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Principles of Silkworm Pathology, Seri Scientific Publishers, P. 420.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P. 215.
9. Krishnaswami, S., Narasimhanna, M.N., Suryanarayan, S.K. and Kumararaj, S., 1979, Silkworm Rearing. FAO Manual, Vol. II, FAO, Rome, pp. 99-129.
10. Narayanaswamy, K.C. and Devaiah, M.C., 1998, Silkworm Uzi Fly. Zen Publishers, Bengaluru, P 232.
11. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection. Central Silk Board, Bengaluru, pp.1 – 324.
12. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P 42.

13. Ullal, S.R. and Narasimhanna, M.N. 1981, Handbook of Practical Sericulture. Central Silk Board, Bengaluru, P.209.

Journals:

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian Silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/

Bivoltine Silkworm Rearing **2 (1+1)**

Objectives

1. Students need to acquire the skills and knowledge about the bivoltine silkworm rearing.
2. To acquaint with the knowledge on bivoltine silkworm rearing.
3. To formulate and execute the silkworm rearing plan by assessing the available resources and season.
4. To acquaint with and enlisting the pros and cons involved in the bivoltine rearing.
5. To assess the prevailing market prices and select suitable market for sale of cocoons.
6. To mitigate the probable unforeseen risks during silkworm crop period.

Theory

Importance of Bivoltine sericulture; JICA method of mulberry cultivation and silkworm rearing; Popular bivoltine races; Importance of disinfection; Disinfection at three levels – rearing house, surroundings, entrance, rotary mountage; Incubation of loose eggs in incubation frames and black boxing; Brushing with double net; Selection of leaf for Chawki rearing; Transferring of larvae to rearing trays, bed cleaning, care during moulting and distribution of chawki larvae; Late age silkworm rearing, silkworm rearing house, shoot rearing stand, hygiene maintenance, transportation and preservation of mulberry shoots, nylon net for uzi fly prevention, space requirement according to instar wise; Mounting of larvae, jobrai method of collection of mature larvae mounting of worms to rotary mountage; Harvesting of cocoons, sorting, packing and marketing; Economics of bivoltine silkworm rearing.

Practicals

Raising mulberry garden as per JICA recommendations which includes INM, IPM, IDM practices, weed management, pruning and harvesting; Rearing of bivoltine silkworm races as per JICA specifications which includes disinfection of silkworm rearing house and appliances; Incubation of eggs, black boxing; Selection and harvesting of leaf for chawki rearing; brushing of layings; Bed cleaning, care during moulting and distribution of chawki larvae; Late age silkworm rearing, silkworm rearing house, shoot rearing stand, hygiene maintenance, transportation and preservation of mulberry shoots, nylon net for uzi fly prevention, space requirement according to instar wise; Mounting of larvae, jobrai method of collection of mature larvae mounting of worms to rotary mountage; Harvesting of cocoons, sorting, packing and marketing; Working out the economics of mulberry cultivation and bivoltine silkworm rearing.

Suggested Readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation volunteers, Japan, P. 594.
2. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P. 376.
3. Dandin, S.B. and Giridhar, 2010, Handbook of Sericulture Technologies. CSB, Bengaluru, P. 427.
4. Forth, H.D., 1991, Fundamentals of Soil Science. John Wiley and Sons, New York, P. 645.
5. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P. 176.
6. Ganga, G., 2003, Comprehensive Sericulture, Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P. 429.
7. Govindaiah, Gupta, V.P., Sharma, D.D., Rajadurai, S. and Nishitha Naik, V., 2005, Textbook on Mulberry Crop Protection, Central Silk Board, Bengaluru, P. 247.
8. Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Principles of Silkworm Pathology. Seri Scientific Publishers, P. 420.
9. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P. 215.
10. Krishnaswami, S., Narasimhanna, M.N., Suryanarayan, S.K. and Kumararaj, S., 1979, Silkworm Rearing. FAO Manual, Vol. II, FAO, Rome, pp. 99-129.
11. Muzafar Ahmad Bhat, Abdul Aziz, Suraksha Chanotra, Shamim Ahmed Bandey, Zafar Iqbal Bhuroo and Mohammad Azam, 2020, A Textbook on Introduction to Sericulture and Soil Science. IP Innovative Publication, New Delhi, P. 425.
12. Narayanaswamy, K.C. and Devaiah, M.C., 1998, Silkworm Uzi Fly. Zen Publishers, Bengaluru, P 232.
13. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection. Central Silk Board, Bengaluru, pp.1 – 324.
14. Savithri, G., Sujathamma, P. and Neeraja, P., 2016, Sericulture Industry: An Overview, pp. 28-35.
15. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P 42.

16. Ullal, S.R. and Narasimhanna, M.N. 1981, Handbook of Practical Sericulture, Central Silk Board, Bengaluru, P. 209.

Journals:

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian Silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/

Personality Development 2 (1+1)

Objective

1. To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B behaviours, Personality and organizational behaviour.

Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception, Attribution theory and case studies on perception and attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behaviour, Learning and training, Learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation - theories and principles, teamwork and group dynamics.

Practical

MBTI personality analysis, Learning styles and strategies, Motivational needs, Firo-B, Interpersonal communication, Teamwork and team building, Group dynamics, Win-win game, Conflict management, Leadership styles, Case studies on personality and organizational behaviour.

Suggested Readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development (6th Edition). Belmont, CA: Wadswor

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art-skill and expertise on management of disasters.

Theory

Introduction to Environment. Environmental studies - Definition, scope and importance, Multidisciplinary nature of environmental studies, Segments of environment, Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Soil resources. Ecosystems - Concept of an ecosystem, Structure and function of an ecosystem, Energy flow in the ecosystem, Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act. Human Population and the Environment: Environment and human health, Human rights, Value education, Women and child welfare, Role of Information Technology in environment and human health.

Disaster management: Disaster definition, Types. Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy

for disaster reduction. Concept of disaster management, national disaster management framework, financial arrangements, role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets (river/forest/grassland/hill/mountain). Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De A.K., 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti P.G., 2011. Disaster management - India's Risk Management Policy Frameworks and Key Challenges. Published by Centre for Social Markets (India), Bengaluru. 36 pp.
3. Erach Bharucha. Textbook for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban K.T., Vennila S., Prasanthrajan M., Umesh Kanna S. 2003. Forest, Environment, Biodiversity and Sustainable Development. Narendra Publishing House, New Delhi (In Press).
5. Prasanthrajan M, P.P. Mahendran., 2008. A textbook on Ecology and Environmental Science. Agrotech Publishing Academy, Udaipur. ISBN 81-8321-104-6. First Edition: 2008.
6. Prasanthrajan M, 2018. Objective Environmental Studies and Disaster Management. Scientific Publishers, Jodhpur, India. ISBN 9789387893825. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment. Rastogi Publications, Meerut, India.
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage Learning Publication, Belmont, USA.

National Cadet Corps (NCC-II) 1(0+1)

- Arms Drill - Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1 (0+1)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

National Service Scheme II

Importance and role of youth leadership

- Importance and role of youth leadership: Meaning, types and traits of leadership, qualities of good leaders, importance and roles of youth leadership
- Life competencies: Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication
- Youth development programs: Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation: Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- Youth and yoga: History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project, factors influencing sensing the opportunities. Infrastructure and support systems - good policies, schemes for entrepreneurship development, role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership, registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection and formulation of project, project report preparation, enterprise management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, and taxation. Marketing managemen t- market, types, marketing assistance, market strategies. Crisis management - raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings:

- Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai V., 2015, Entrepreneurship: Development and Management. Himalaya Publishing House.
- Desai, Vasant 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House.
- Gupta C.B., 2001, Management Theory and Practice. Sultan Chand and Sons.
- Grover, Indu 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.

- Khanka S.S., 1999, Entrepreneurial Development. S. Chand and Co.
- Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
- Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh D., 1995, Effective Managerial Leadership. Deep and Deep Publications.
- Singhal R.K., 2013, Entrepreneurship Development and Management. Katson Books.
- Tripathi P.C. and and Reddy P.N., 1991, Principles of Management. Tata McGraw Hill.

SEC-II

Silkworm Rearing Technology 4 (0+4)

Objectives

1. Enhancement of rearing skill of the students for cocoon production.
2. To improve quality and quantity of cocoon production through induction of modern rearing technology in Sericulture.

Practical

1. Life cycle of silkworm *Bombyx mori*
2. Study of plan for rearing house - chawki and late-age silkworm rearing house
3. Study of different rearing equipment/appliances
4. Disinfectants and their applications
5. Study of egg incubation methods and black boxing
6. Study of brushing of silkworms and selection of leaf for different instars
7. Study of bed cleaning methods and moulting worms and management
8. Study of different types of chawki and types of late-age silkworm rearing methods
9. Study of shoot feeding method and shelf rearing method
10. Role of environmental factors, micro- and macro-nutrients on growth and development of silkworms
11. Identification of ripe worms and methods of mounting
12. Study of fortification of mulberry leaves and artificial diet in silkworm rearing
13. Study of use of juvenile hormone analogs on silkworm rearing
14. Harvesting of cocoons, transportation and marketing of cocoons
15. Study of natural enemies of silkworms
16. Study on maintenance of rearing records
17. Visit to chawki rearing centers
18. Visit to farmers mulberry garden, rearing house and cocoon market

Suggested Readings

1. Handbook of sericulture technologies - Dr S B Dandin and Dr K Giridhar. CSB
2. An introduction to sericulture – G Ganga and Sulochana Chetty
3. FAO manual on sericulture.
4. Silkworm crop protection - Dr B Nataraju, Dr K Sathyprakash, Dr D Manjunath and Mr C Aswani Kumar.
5. Intensive bivoltine sericulture technology package. CSR&TI, Mysore.

Silk Reeling Technology 4 (0+4)

Objectives

1. To practice cocoon reeling
2. To acquaint with the skills of cocoon reeling in multiend reeling machine

Practical

Crossbreed cocoon reeling in multiend reeling machine by floating system – Basket method of steam stifling, cocoon cooking and brushing by open (single) pan method. Practicing the reeling path in multiend reeling machine with 150 -200 rpm reeling speed. Putting the tavellette croissure and maintaining a rawsilk denier of 20/22d. Reel permeation by soaking method and re-reeling by closed type re-reeling machine with 200-250 rpm speed, lacing, silk examination and skeining.

Bivoltine cocoon reeling in multiend reeling machine by sunken system – hot air stifling by batch method using hot air oven or ushnakoti. Partial drying or complete drying of cocoons. Pressurised cooking by circular cocoon cooking unit, brushing by individual mechanical bushing unit, reeling cocoons in sunken system in multiend reeling machine. Putting the tavellette croissure and maintaining a rawsilk denier of 20/22d. Reel permeation by soaking method and re-reeling by closed type re-reeling machine with 200-250 rpm speed, lacing, silk examination and skeining.

Dupion silk reeling using the double and reelable defective cocoons in charaka and producing raw silk yarn of above 60D. Working out the economics of crossbreed, bivoltine and dupion raw silk production.

Suggested Readings

1. Anonymous, 2003, Seri business manual. CSB.
2. Anonymous, 2003, Vanya silks, CSB.
3. Krishnaswami S., Madhava Rao N.R., Suryanarayan S.K. and Sundaramurthy T.S., 1972, Sericulture Manual 3- silk reeling. FAO, Rome. p.112.
4. Mahadevappa, V.G. Haliyal, D.G. Shankar and Ravindra Bhandiwad, Mulberry silk reeling technology.
5. Tammanna N. Sonuwalker, Handbook of silk technology.
6. Yong-woo Lee, Silk reeling and testing manual. National Sericulture and Entomology Institute, Seoul, Republic of Korea.

SEMESTER-III

S. No.	Course Title	Credit Hours
SCP 211	History, Development and Organization of Sericulture Industry	1(1+0)
SCI 211	Botany and Cytology of Host Plants of Silkworm	3 (2+1)
SCI 212	Genetics and Breeding of Host Plants of Silkworms	3 (2+1)
SCI 213	Cytology and Genetics of Silkworm	2 (2+0)
ENT 211	Fundamentals of Entomology and Nematology	3 (2+1)
GPB 211	Fundamentals of Genetics	2 (1+1)
AGR 211	Fundamentals of Agronomy	3 (2+1)
AEC 211	Physical Education, First Aid and Yoga Practices	2 (1+1)
SEC 211/212/213	SEC 3: Skill for Employment and Entrepreneurship Development/Skill Enhancement Course	2 (0+2)
	Total	**21 (13+8)**

*From the basket of available SEC-III modules.

Indicative options for SEC – III** (any one module to be selected)

S. No.	Course Title	Credit Hours
	Module-SEC-3	
SEC 211	Raw Silk Processing	2 (0+2)
SEC 212	Weaving Technology	2 (0+2)
SEC 213	Seri Clinic	2 (0+2)

**The universities/ institutes are free to include other options for SEC as per the local needs and facilities available, also to interchange the modules in between semesters. The modules can be taken in campus or off-campus.

History, Development and Organization of Sericulture Industry 1 (1+0

Objectives

1. To understand history and organization setup of sericulture in India.
2. To develop the technical knowledge on role and responsibilities of sericultural organization.

Theory

1. Introduction, definition of sericulture, importance of sericulture, advantages of sericulture in Indian context
2. Brief mention about four major types of silks in India with their scientific names and primary host plants
3. Leading silk producing countries in the world and states in India, traditional sericultural districts in Karnataka
4. History of sericulture in China and its spread to Korea, Japan, Europe and India
5. Development of Sericulture in India with special reference to south India
6. National and International Organizations related to sericulture, their role in development of sericulture industry, different developmental projects in sericulture, main objectives of NSP

7. Central Silk Board, its function, different regional offices of CSB and their role in sericulture development, training facilities in CSB
8. Organizational setup of State Departments of Sericulture and KSSR&DI
9. Cocoon markets and their mode of functioning
10. Quality control and marketing of silk, objectives of silk exchange, role of KSMB in Sericulture development, role of export import policy in price stabilization
11. Development of Sericultural Education in India
12. Voluntary Organizations and their role in development of sericulture, development through social, organizational and technical aspects

Suggested readings

1. Abdul, Aziz and Hanumanthappa, H.G., 1985, Silk Industry Problems and Prospects. Ashish Publishing House, New Delhi, p.129.
2. Anonymous, 2007, Sericulture and Silk Industry Statistics. Central Silk Board, Bengaluru, p.96.
3. Ganga, G., 2003, Comprehensive Sericulture - Vol. 2. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp.1-16.
4. Ganga, G. and Sulochana Chetty, J., 2001, An Introduction to Sericulture. Ashish Publishing House, New Delhi, pp.1-23.
5. Hanumappa, H.G.,1993, Sericulture Society and Economy. Himalaya Publishing House, Bombay, p.140.
6. Koshy, T.D., 2001, Silk Production and Export Management. A.P.H. Publishing Corporation, New Delhi, p.656.
7. Sanjay Sinha, 1990, Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, p.103.
8. Vekata Narasaiah, P., 1992, Sericulture in India. Ashish Publishing House, New Delhi, p. 214.

Botany and Cytology of Host Plants of Silkworms 3 (2+1)

Objectives

1. To study the botanical classification and cytological details of hosts plants of mulberry
2. To understand the breeding systems of different hosts plants of different silkworm, basic cell program, cell life cycle, seed formation anatomy of plants and cytological details like chromosomal number and their behavior during division, ploidy level, etc.

Theory

1. Taxonomy, systematics and botanical description of mulberry, mulberry silk worm host plant
2. Taxonomy, systematics and botanical description of Terminalia and Quercus, host plants of tasar silk worm
3. Taxonomy, systematics and botanical description of Som and Soalu, host plants of Muga silkworm
4. Taxonomy, systematics and botanical description of castor, tapioca and kessaru, host plants of Eri silkworm

5. Poly embryonic seed in mulberry
6. Mitosis and karyo morphological studies in host plants of silkworms
7. Micro and mega sporogenesis and fertilization in mulberry. Fruit seed development and parthenocarpy in mulberry.

Practical

1. Botanical description of mulberry
2. Botanical description of Terminalia and Quercus
3. Botanical description of Som and Soalu
4. Botanical description of castor, tapioca and kessuru
5. Anatomy of root, stem, leaf, fruit and seed in mulberry
6. Micro and mega sporogenesis and fertilization in mulberry
7. Squashing and smearing techniques in mulberry
8. Karyo morphology and idiogram in some host plants of silkworms

Genetics and Breeding of Host Plants of Silkworms 3 (2+1)

Objectives

1. To study the breeding methods that can be employed for improvement of host plants of silk worm.
2. Studying the flower biology, modes of reproduction, principles, methods of breeding specifically can be adopted for specific host plants of silk worm.

Theory

1. Germplasm sources, geographical distribution and exploration. Centres involved in crop improvement program of host plants of silkworms.
2. Conservation and role of germplasm in crop improvement. Inheritance of economic characters (quantitative and qualitative characters).
3. Breeding methods for self and cross pollinated crops.
4. Objectives and pre-requisites of mulberry breeding.
5. Methods of breeding, viz., introduction and acclimatisation, methods of selection in mulberry.
6. Hybridization, heterosis breeding, backcross, population improvement, mutation breeding, polyploid breeding.
7. Breeding for resistance to biotic and abiotic factors - drought, diseases, pests, salinity and alkalinity.
8. Breeding for leaf quality.
9. Evaluation and statistical approach for yield test in mulberry. Varietal multiplication and dissemination.

Practical

1. Procedure for mass and pedigree selection, and its uses in mulberry improvement
2. Techniques of hybridization in mulberry and its appliances necessary for breeding

3. Procedure for collection of pollen and artificial pollination in mulberry, details of recording data
4. Procedure for induction of polyploidy in mulberry-treatment with colchicine
5. Different techniques of induction of mutation

Cytology and Genetics of Silkworm 2 (2+0)

Objectives

1. General objectives of the course study of cell and its components.
2. To know number of Chromosomes in different species of Silkworms and identification.

Theory

1. History of cytology and genetics
2. Basic terminology of cytology and genetics
3. Biology of the silkworm *Bombyx mori*
4. Cell and types of cell
5. Cell cycle (Mitosis and Meiosis)
6. Chromosome and structural models of chromosomes
7. Structure and chemical composition of nucleic acids
8. Mendels laws of inheritance
9. Genetic interactions and its methods
10. Concepts of crossing over and types crossing over
11. Linkage and chromosomal maps
12. Concept and principles of maternal inheritance in silkworm
13. Qualitative and quantitative characters in silkworm
14. Concepts of genotype, phenotype
15. Concepts, heritability and genetic advance
16. Hereditary traits of silkworms at different stages
17. Conservation strategies of genetic Stocks of silkworms
18. Genetic basis of hormonal mechanism in silkworm
19. Sex determination in silkworms

Suggested readings

1. Gardner, E.J., Simmous, M.J. and Snustad, D.P., 1991, Principles of Genetics. John Willey and Sons Inc., New York. P. 649.
2. Principles and Techniques of Silkworm Breeding, ESCAP, UN, New York. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. P. 111.
3. Sarkar, D.D., 1998, The Silkworm Biology, Genetics and Breeding. Vikas Publishing House Pvt. Ltd., New Delhi. P. 338.
4. Singh, B.D., 1997, Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi. P. 702.

5. Singh, B.D., 2012, Fundamental of Genetics. Kalyani Publishers, New Delhi. P. 719.
6. Tazima, Y., 1964, The Genetics of Silkworm. Logos Press Ltd., London. P. 253.
7. Tazima, Y., 1978, The Silkworm: An important Laboratory Tool. Kodansha Ltd., Tokyo, Japan. P. 307.

Fundamentals of Entomology and Nematology 3 (2+1)

Objectives

1. Students needs to be acquire the skills, knowledge and experiences on Entomology and Nematology.
2. To gain knowledge on insects and nematodes.
3. To acquaint and enlist the reasons responsible for insect dominance in animal kingdom.
4. To study morphology, anatomy and taxonomy of insects in relation to silkworm. To impart dissection skills.

Theory

1. Definition and need to study Entomology, Position of insects in the animal kingdom and general organisation of phylum arthropoda. Characters of Class Insecta, Dominance of insects in the Animal kingdom: Factors responsible for dominance.
2. General morphology of insects: Body division and segmentation, History of Entomology in India. Structure and functions of body wall and its appendages, moulting process, Segmentation of the body.
3. Structure of Insect – Head - areas and sutures, Appendages of the head. Structure and types of antenna – modifications of insect antennae with examples. Johnston's organ – location and function, General structure of typical biting and chewing type of an insect: mouth parts – types of mouth parts.
4. Structure of thorax- Leg structure and its modification with examples. Wings: Structure of typical wing, wing venation, modifications and wing coupling mechanisms. Structure of abdomen and its appendages – Non-reproductive appendages and Reproductive appendages, structure of male and female genetalia and structure of sting in bees.
5. Sensory organs in insects – structure and function. Insect communication: Sound production, light production, honey bee dances, insect pheromones. Metamorphosis, types of insect metamorphosis and diapause in insects. Types of larvae and pupae, Head glands, Digestive system of insects.
6. Circulatory system – Functions of haemolymph, Respiration in insects (Ventilation), Excretory system, Nervous system , Reproductive system, types of reproduction in insects.
7. Definition of Taxonomy, systematics, classification and its importance, Brief history of classification, Nomenclature definition, objectives, guidelines Binomial nomenclature as indicated by ICZN. Definitions of Biotypes, species, sub species, genus, family, order, tribe, hierarchy, Taxonomic categories; type concept in nomenclature, general classification of Insects up to orders.
8. General classification of insects – phylogeny of insects, Study of apterygotan orders - Collembola, Protura, Diplura, Thysanura Ephemeroptera and Odanata.

9. Study of the representatives of the orders Blattodea, Mantodea Isoptera and Orthoptera Hemiptera and suborder: Homoptera
10. Study of the insect orders – Neuroptera, Siphonaptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera.
11. Introduction, History and characteristics of Plant parasitic nematodes, economic importance of nematodes in mulberry.
12. Characteristics of Phylum Nematoda and its relationship with other related phyla, history and growth of Nematology.
13. Nematode habitats and diversity- plant, animal and human.
14. Nematode morphology and and anatomy of plant parasitic nematodes, stages of nematodes.
15. Broad classification of nematodes.
16. Reproduction of nematodes.
17. Types of parasitism; nature of damage, symptomatology; interaction of plant-parasitic nematodes with other organisms.
18. Importance of nematodes in international trade and quarantine.
19. Useful nematodes. Principles and practices of nematode management.
20. Integrated nematode management.

Practical

1. Study of the phylum Arthropoda, Insect collection and preservation, Study of the class Insecta
2. Study of the antennae, legs, and wings of insects. Internal anatomy of the cockroach, morphology of honey bees and house fly, morphological variations in insects with special reference to the mouth parts
3. General classification of the class Insecta – study of sub class Apterygota, Ephemeroptera, Odanata, Plecoptera, Orthoptera and Phasmida Hemiptera and suborder: Heteroptera
4. Neuroptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera
5. Equipment's used in nematology laboratory
6. Studies on kinds of nematodes - free-living, animal, insect and plant parasites
7. Nematode extraction from soil, extraction of migratory endoparasites, staining for sedentary endoparasites
8. Examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology
9. Study of perennial pattern in Root knot nematodes

Suggested readings

1. Bhat Muzafar Ahmad , Abdul Aziz, Suraksha Chanotra, Shamim Ahmed Bandey, Zafar Iqbal Bhuroo and Mohammad Azam. 2020. A Textbook on Introduction to Sericulture and Soil Science. IP Innovative Publication, New Delhi, P.425.
2. Chapman, R.F. 1998. The Insects - Structure and Function. Cambridge University Press, UK.
3. Metcalf, C.L. and Flint., W.P. 1990. Fundamentals of insect life. McGraw Hill Publishing Company Ltd., New Delhi

4. Richards, O.W. and Davies, R.G. 1997. Imm's General Textbook of Entomology. Vol-I&II, Hall and Oxford Publication
5. Romoser, W.S. and Stoffolano, J.G. 1994. The Science of Entomology. Wm. C. Brown Publishers, Oxford, England
6. Ullal, S.R. and Narasimhanna, M.N. 1981. Handbook of Practical Sericulture. Central Silk Board, Bengaluru, P.209.

Journals

1. Annual Review of Entomology.
2. Journal of Economic Entomology.
3. Journal of Medical Entomology.
4. Environmental Entomology.
5. Medical and Veterinary Entomology.
6. Ecological Entomology.
7. Systematic Entomology.
8. Physiological Entomology.

Online Sources

- www.cabi.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/

Fundamentals of Genetics 2 (1+1)

Objectives

1. To educate students about genes, genetic variations and heredity in organisms
2. To develop knowledge on mendelian principles of heredity and medelian exceptions
3. To impart knowledge on qualitative and quantitative traits inheritance
4. To bring a knowledge on application of probability and chi-square to solve genetic problems
5. To make understand the concepts of linkage, genetic map, gene and gene regulations (Lac and Tryp operons)

Theory

1. Pre- and Post-Mendelian concepts of heredity
2. Mendelian principles of heredity
3. Probability and Chi-square
4. Types of dominance, epistatic interactions with examples
5. Multiple alleles, pleiotropism, Blood group genetics
6. Sex determination and sex linkage, sex limited and sex influenced traits
7. Linkage and its estimation, crossing over mechanisms, chromosome mapping
8. Mutation, classification, mutagenic agents and induction of mutation

9. Qualitative and Quantitative traits; Polygenes and continuous variations, multiple factor hypothesis
10. Cytoplasmic inheritance
11. Protein synthesis, Transcription and translational mechanism of genetic material
12. Gene concept: gene structure, function and regulation, Lac and Trptophan operons

Practicals

1. Solving problems on monohybrid, dihybrid, trihybrid
2. Solving problems on epistatic interactions including test cross and back cross
3. Concepts of probability and Chi-square test and their application in genetics
4. Detection and estimation of linkage through two-point test cross and three-point test cross data
5. Solving problems of sex linkage

Suggested readings

1. Benjamin, A. 2010. Genetics: A Conceptual Approach. Published by W.H. Freeman and company, England.
2. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons, Inc.
3. Robert H. Tamarin, 2017. Principles of Genetics (7th Ed.). McGraw Hill Education.
4. Singh, B.D. 1990. Fundamentals of Genetics. Kalyani Publishers, New Delhi.
5. Singh, Phundan. Elements of Genetics. Kalyani publishers, New Delhi.
6. Stansfield, W.D. 1991. Theory and Problems of Genetics (3rd Ed.) Schaum's Outline Series, McGraw Hill, Inc.
7. Strickberger, M.W. 1995. Genetics (3rd Ed.). Prentice Hall of India, New Delhi.

Fundamentals of Agronomy 3 (2+1)

Objectives

1. To enable the thought process by giving emphasis on applications of Agronomy in Agriculture.
2. To study in detail about the cultivation techniques required for efficient crop production from sowing to harvest.

Theory

1. Agriculture: definition, meaning, importance and scope of agriculture
2. History of agriculture development in India and Karnataka
3. Agriculture as an art, science and business of crop production, Agronomy- definition, meaning and its scope, factors affecting crop production
4. Agrarian classification of crops, seeds and sowing, soil and its components
5. Soil fertility, soil productivity and their management practices
6. Tillage and tilth

7. Crop density and geometry
8. Crop nutrition, manures and fertilizers, nutrient-use efficiency
9. Growth and development of crops, concept of ideotypes
10. Cropping systems: definition, principles and types of cropping system
11. Agro-climatic zones of India and Karnataka
12. Crop adaptation and distribution, crop management technologies in problematic areas
13. Irrigation: Introduction, Importance, definition and objectives, methods of irrigation
14. Weeds: definition, classification and characteristics, crop weed competition, concepts of weed management – principles and methods
15. Herbicides – classification, selectivity and resistance, Methods of application
16. Allelopathy, types of allelopathy

Practical

1. Identification of crops, seeds and fertilizers
2. Classification of field crops, tillage implements
3. Study and practice of different methods of ploughing, Study of different methods of sowing
4. Study of seed drills, intercultural implements,
5. Study of fertilizers, manures and green manures
6. Calculation of fertilizers and seed rates
7. Study on seed germination and plant population
8. Preparation of FYM and compost
9. Participation in ongoing field operations, study and identification of dry land and waste land weeds.
10. Study of agro-climatic zones of Karnataka and India
11. Study and identification of garden land, wet land and aquatic weeds
12. Calculation of herbicide doses and their spray
13. Herbarium, preparation of herbariums of different weeds

Suggested readings

1. J. P. Chaudhary, Fertilizers and Manures
2. K. L. Nandeha, Agronomy
3. S. C. Panda, Cropping and Farming Systems
4. S. R. Reddy, Introduction to Agronomy and Principles of Crop Production
5. Yellamanda Reddy, T and Shankar Reddy, G. H. 2016, Principles of Agronomy. Kalyani Publishers, New Delhi

Physical Education, First Aid, Yoga Practices and Meditation 2 (1+1)

Physical education; Training and coaching - Meaning and concept; Methods of training; Aerobic and anaerobic exercises; Calisthenics, weight training, circuit training, interval training,

Fartlek training; Effects of Exercise on muscular, respiratory, circulatory and digestive systems; Balanced Diet and Nutrition: Effects of diet on performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and achievements in sports; Learning and theories of learning; Adolescent problems and its management; Posture; Postural deformities; Exercises for good posture.

Yoga; Introduction to Asanas, Pranayama, Meditation and Yogic Kriyas; Role of yoga in sports; Teaching of Asanas – demonstration, practice, correction and practice.

Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. Handling and transport of injured traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration. Treatment of injuries (wounds and bleeding)–methods of dressing and bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of burns and scalds. Emergency procedure for poisoning with special references to snakebite injuries to muscles and joints and treatments. Sports injuries and their treatments.

SEC-III

Raw Silk Processing 2 (0+2)

Objectives

1. To understand the processing of raw silk yarn for weaving a fabric
2. To acquaint with the skills of raw silk processing for fabric production

Practicals

Twisting of raw silk (Throwster's unit) - Soaking of raw silk, winding, doubling – making different plys of silk yarn, mixing up of the yarns and twisting. Different types of twist – S twist, Z twist and production of different types of yarns. Steaming and Re-reeling. Maintenance of working condition of throwsters unit. Working out tho economics of cost of production of twisted yarn. Wet processing of twisted silk yarn - Degumming – methodology. Dyeing of yarn – different types of dyes, methods of dyeing and its application for silk dyeing. Warp making – different methods of warping – ball warping, drum warping. Weft yarn prepartion. Working out the economics of silk warping. Visit to throwsters unit and warp making units.

Suggested readings

1. Anonymous, 2003, Seri-Business Manual, Vol. 3 Industrial sector. CSB.
2. Kanwar Varinder Pal Singh, 2004, Elementary Idea of Textile Dyeing, Printing and Finishing. Kalyani Publishers, p.186.

Weaving Technology 2 (0+2)

Objectives

1. This course aims at updating the knowledge of students in the fields of weaving preparatory and waving technology.
2. Fundamental aspects of warp and weft winding machines.
3. Fundamentals of weaving and basic motions of weaving.

Practicals

Introduction to the weaving; Selection of raw silk, procurement, preparation of raw silk yarn; Arrangement of looms; Pit loom, Frame loom, Power loom; Self designed; Jacquard looms, Dobby operation. Weaving of the fabric, Designing of the fabric, Plain or designed weaving, Zari work, Hand working on plain fabrics; Normal finish packaging of sarees, dress material Starch, Chemical finishing of the fabric tautening, ironing. Marketing of the fabric, project preparation and calculation of B/C ratio in weaving.

Suggested readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation volunteers, Japan, P.594.
2. Anonymous, 2000, Do's and Don'ts of Silk Twisting and and Weaving Industry Part – II (Weaving). Central Silk Board, Bengaluru, P.35.
3. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P.376.
4. Bhattacharya, M. and Mahadevappa, D., 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, P.460.
5. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
6. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P.429.
7. Goswami, B.C., Martindale, J.G. and Scardino, F.L., 2010, Textile Yarns: Technology, Structure and Applications. Wiley India Edition, New Delhi, P.565.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P.215.
9. Mishra, S.P., 2006, A Textbook of Fibre Science and Technology. New Age International Publishers, New Delhi, P.326
10. Reddy, D.N.R., Shylaja, T.A. and Narayanaswamy, K.C., 2000, Reshmae Vasthra Vinyasa. CVG Publicaions, Bengaluru, P.78.
11. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P42.
12. Ullal, S.R. and Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. Central Silk Board, Bengaluru, P.209.

Journals

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian Silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/
- www.nift.ac.in/

Seri Clinic 2 (0+2)

Objectives

1. This course aims to start-up the Seri Clinic envisaged to provide advice and services to farmers on various aspects to enhance cocoon productivity and increase the incomes of farmers.
2. Seri-Clinics course provide knowledge and expertise in the following areas:
   - I. Soil health
   - II. Mulberry and non-mulberry crop production including protection
   - III. Silkworm rearing plans
   - IV. Cocoon crop protection
   - V. Crop insurance clinical services for animals, feed and fodder management
   - VI. Cocoon prices in various market, etc.
   - VII. Resources management

Practicals

Soil health diagnosis, INM practices to improve the soil and plant health, Identification of deficiency symptoms in mulberry and non-mulberry and acquainting with remedial measures, Diagnosis of pest and diseases of silkworm and acquainting with remedial measures, Survey of problematic mulberry and non-mulberry garden and rearing houses and find out the remedies for the cause, Assessment of quality of the inputs, leaf and DFL's., Assessment of toxicity, their nature, level and suggest remedies, Development of INM, IPM and IDM schedules for management of nutrition and pest and diseases in mulberry.

Suggested readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation volunteers, Japan, P.594.

2. Anonymous, 2000, Do's and Don'ts of Silk Twisting and Weaving Industry Part – II (Weaving). Central Silk Board, Bengaluru, P.35.
3. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P.376.
4. Bhattacharya, M. and Mahadevappa, D., 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, P.460.
5. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
6. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P.429.
7. Goswami, B.C., Martindale, J.G. and Scardino, F.L., 2010, Textile Yarns: Technology, Structure and Applications. Wiley India Edition, New Delhi, P.565.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P.215.
9. Mishra, S.P., 2006, A Textbook of Fibre Science and Technology. New Age International Publishers, New Delhi, P.326
10. Reddy, D.N.R., Shylaja, T.A. and Narayanaswamy, K.C., 2000, Reshmae Vasthra Vinyasa. CVG Publicaions, Bengaluru, P.78.
11. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P42.
12. Ullal, S.R. and Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. Central Silk Board, Bengaluru, P.209.

Journals

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian Silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/

S. No.	Course Title	Credit Hours
SCP 221	Morphology and Systematics of Silkworm	3 (2+1)
SCP 222	Silkworm Anatomy and Physiology	3 (2+1)
AGR 221	Water Management	2 (1+1)
AST 221	Agriculture Statistics	2 (1+1)
MDC 221	Agricultural Marketing and Trade	3 (2+1)
VAC 221	Agricultural Informatics and Artificial Intelligence	3 (2+1)
SEC 221/222	SEC 4: Skill for Employment and Entrepreneurship Development	2 (0+2)
	Total	**18 (10+8)**

*From the basket of available SEC modules.

Indicative options for SEC – IV** (any one module to be selected)

Sl. No.	Course Title	Credit Hours
	Module-SEC-4	
SEC 221	Value Addition in Sericulture	2 (0+2)
SEC 222	Entrepreneurship and Business Development in Sericulture	2 (0+2)

**The universities/ institutes are free to include other options for SEC as per the local needs and facilities available, also to interchange the modules in between semesters. The modules can be taken in campus or off-campus.

Post-Semester IV* (Only For exit option for UG-Diploma in Sericulture)

S. No.	Course Title	Credit Hours
SDE 221	Internship (10 weeks)	10 (0+10)

*Mandatory requirement for UG-Diploma.

On exit, the students will be eligible to be awarded UG-Diploma in Sericulture.

A student studying any one of the following modules will get a Diploma in Sericulture

Nomenclature of Diploma	Module taken	
	Semester-III	Semester-IV
UG Diploma in Sericulture	SEC-3	SEC-4

Morphology and Systematics of Silkworms 3(2+1)

Objectives

1. To identify the sericigenous fauna
2. To understand the basic principles of morphology
3. To understand the basic principles of systematics
4. Understanding the type concept
5. To establish confidence in systematics and morphology of sericigenous insects

Theory

1. Introduction to morphology, why to study morphology

2. Definitions and its relation to Anatomy, Physiology and Ecology.
3. Systematics, Taxonomy, Classification, Class, Order, Genera, Species
4. Objectives of systematic, classification and taxonomy
5. Functions of systematics, Zoological nomenclature, objectives of ICZN
6. Law of priority – Homonyms, Synonyms
7. Type concepts: Types at species level- Holotype, Syntype, Lectotype, Paralectotype and Allotype
8. Levels of taxonomy/Classification of Mulberry silkworm, Tropical Tasar, Temperate tasar, Eri and Muga silk silkworm
9. General insect morphology: Metamorphosis, life cycle
10. Integument- Basement membrane, Epidermis and cuticle, composition of cuticle, Cuticular modifications: 1. Cellular membrane, 2. Apodeme and Apophysis
11. External processes: 1. Acellular: spicules, small spines, cuticular hairs, corrugations and ridges; 2. Cellular processes: Unicellular (Setae) and Multi-cellular (spines, spurs)
12. Cuticular modifications (forms of spine and spurs) in lepidopteran larvae: simple primary hairs, chalaza, scoli, vericule, verruca
13. General insect morphology: The head, head segmentation
14. Procephalon, Gnathocephalon
15. Orientation of the Head: Prognathus, Hypognathus, Opisthognathus
16. Structure of the head, regions of the head, Head appendages
17. General insect morphology: Thorax: Segmentation in the thorax
18. Thoracic appendages – Legs, The wings (Generalized insect wing)
19. Wing coupling and types
20. General insect morphology: Abdomen: Segmentation of the abdomen, abdominal appendages, pre-genital appendages, collembolan appendages, larval leg and gills like appendages, genital appendages (male and female genitalia)
21. Chaetotaxy: primary setae, secondary setae, nomenclature of setae, setal map, setal arrangement in silkworm
22. Arrangement of primary setae in the first instar of mulberry silkworm
23. Morphology of eggs of silkworms: Structure, morphology and follicular imprints of Mulberry silkworm, temperate and tropical tasar, eri and muga silkworms
24. Morphology of *Bombyx mori* L. larvae, head, thorax, abdomen and its appendages, larval marking, moulting and mounting, life cycle
25. Morphology of mulberry silkworm pupa, adult, differentiation of sex, cocoon characters
26. Morphology of tropical and temperate silkworm – larval characters, developmental morphology: prothoracic hood, marking on the anal flap and claspers, larval lines, tubercles, setae (body setae, tubercular setae, shining spots)
27. Morphology of cocoons, pupae, adult- wings, wing venation, ocellus, scales on different parts of tropical and temperate silkmoth
28. Morphology of Muga, *Antheraea assamensis* – larval characters, developmental morphology

of prothoracic hood, marking on the anal flap and claspers, tubercles, pupa, cocoon and adult – ocellus, wing venation

29. Morphology of Eri, Samia ricini larval characters, developmental morphology of prothoracic hood, marking on anal flap and claspers, tubercles, pupa, cocoon and adult –wing venation.

Practical

1. Good Laboratory Practices.
2. Study of collection and preservation of insect specimens.
3. Study of classification of insects and silkworm.
4. Study of insect antennae and mouth parts.
5. Study of insect legs and wings.
6. Study of immature stages of insects.
7. Study of *Bombyx mori* L. egg.
8. Study of head and its appendages of *Bombyx mori* L. larva.
9. Study of thorax and abdomen and their appendages of *Bombyx mori* L. larva.
10. Study of morphology of *Bombyx mori* L. cocoon and pupa.
11. Study of morphology of adult *Bombyx mori* L. (head, thorax, abdomen and appendages)
12. Study of adult *Bombyx mori* L. (legs, wings and scales).
13. Study of taxonomy of Antheraea.
14. Study of morphology of *Antheraea mylitta* (tropical tasar).
15. Study of morphology of *Antheraea assamensis* (muga).
16. Study of morphology of *Samia ricini* (eri).

Suggested readings

1. Dilip De Sarkar., 1998, The Silkworm – Biology, Genetics and Breeding. Vikas Publishing House Pvt. Ltd., New Delhi.
2. IMMS, A.D., 1961, General Textbook of Entomology. 9th Edn., Rev. by O.W. Richards and R.G. Davies, Bombay.
3. Saxena, A.B., 1996, Development of Behaviour in Insects. Anmol Publications Pvt. Ltd., New Delhi.
4. Saxena, A.B., 1996, Principles of Insect Morphology. Anmol Publications Pvt. Ltd., New Delhi.
5. Saxena, A.B., 1996, Ecology of Insects. Anmol Publications Pvt. Ltd., New Delhi.

Silkworm Anatomy and Physiology 3 (2+1)

Objectives

1. To understand the basic principles of anatomy, different organs/systems such as respiratory, circulatory, digestive, nervous and reproductive systems and their functional aspects (physiology) of sericigenous insects to strengthen the knowledge of students.
2. To provide information on silk production among various sericigenous insects, their evolution and differences will also be studied.

Theory

1. Introduction - meaning of the terms anatomy and physiology, a list of visceral organs in silkworm with their function. Anatomy of digestive system of mulberry silkworm and cross-section through fore gut, mid gut and rectum
2. Digestive system of silk moth. Physiology of digestion-glands associated with digestion, digestive enzymes, digestion and absorption
3. Anatomy of circulatory system - organs of circulation (Diaphragms and sinuses, Dorsal blood vessel in silkworm and silk moth and Accessory pulsatory organs). Silkworm blood - plasma and haemocytes and their functions, circulation of blood, pulsation and reversal of pulsation
4. Anatomy of respiratory system components of insect respiratory system (spiracles, trachea, tracheoles and end cells), types of respiratory system based on the number of functional spiracles, respiratory system in silkworm and adult
5. Physiology of respiration - amount of respiration, respiratory co-efficient and respiratory hindrances in silkworm. Metabolism of carbohydrates (glycolysis, Kreb's cycle and ETC), lipids and proteins
6. Anatomy of Excretory system organs of excretion, integument, tracheal system and malpighian tubules. Accessory organs of excretion (nephrocytes, fat bodies and oenocytes). Malpighian tubules in silkworm as a principle excretory organ, modification in silk moths. Physiology of excretion - generalizations on the activity of malpighian tubules, formation of uric acid and urea in silkworm
7. Nervous system - general aspects (neuron; types of neurons). Nervous system in silkworm - central nervous system and visceral or sympathetic nervous system. Modifications in the central nervous system of adults
8. Sense organs visual organs (simple and compound eyes), mechanoreceptors (Trichoid sensilla, chordotonal organs and multipolar stretch receptors), auditory organs (Tympanal organs, auditory hairs, Johnston's organs and pilifer of choerocampine hawk moths) and chemoreceptors. Physiology of nervous system (conduction of stimulus - resting potential and action potential)
9. Anatomy of reproductive system - Gonads in larval stage, male and female reproductive systems, cross-section of a testis and structure of a typical spermatic tube. Structure of an ovariole. A brief on spermatogenesis and oogensis. Kinds of eggs in lepidopterans
10. Endocrine system, Nuerosecretory cells, Corpora cardiac, Corpora allata. Prothoracic glands and Sub-esophageal glands, their secretions and functions
11. Exocrine glands silk glands, scent glands and accessory gland of reproductive system. Muscular system - categories of muscles (skeletal and visceral), muscles in silkworm. Hormonal mechanism of moulting, physiology of diapause (classification based on occurrence - obligatory' and facultative: based on stage - embryonic, larval, pupal and imaginal)
12. Physiological changes during onset of diapauses and termination of diapauses. Effect of photo period and temperature on occurrence of diapauses. Host preference and Stimuli (olfactory and gustatory) of feeding artificial diets for silkworm composition, advantages and limitations, substitution of food plants

13. Application of juvenile hormones (JH) in sericulture, JH Analogues (JHAs). Techniques of application, effect of JHAs on silk production, limitations. Anti-juvenile hormones and their effects
14. Nutritional requirement of silkworm - amino acids, lipids, carbohydrates, vitamins, minerals and water
15. Anatomy of digestive system, respiratory system, reproductive system and nervous system in *Antheraea mylitta* and *Samia ricini.*

Practicals

1. Study of mouth parts in *Bombyx mori* L.
2. Study of the digestive system in the larvae of *Bombyx mori* L.
3. Study of circulatory system in *Bombyx mori* L. larva
4. Study of digestive system in the adult of *Bombyx mori* L.
5. Study of respiratory system in the larva of *Bombyx mori* L.
6. Study of respiratory system in the adults of *Bombyx mori* L.
7. Study of central nervous system in the larva of *Bombyx mori* L.
8. Study of central nervous system in the adult of *Bombyx mori* L.
9. Study of excretory system in the larvae of *Bombyx mori* L.
10. Study of female reproductive system in *Bombyx mori* L.
11. Study of male reproductive system in mulberry silk moth
12. Study of internal organs of larva of tropical/temperate tasar silk worm *Antherea mylitta* D
13. Study of internal organs of larva of tropical/temperate tasar silk worm *Antherea mylitta* D
14. Study of internal organs of larva of eri silk worm *Samia ricini* Boisduval
15. Study of internal organs of eri silk moth *Samia ricini* Boisduval.

Suggested readings

1. Ather H. Siddiqi, 1982, Experimental Physiology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
2. Beck, S.D., 1963, Animal Photoperiodism. Holt, Holt Library of Science Series, New York.
3. Beck, S.D., 1980, Insect Photoperiodism. Academic Press, New York.
4. Gilmour, D., 1961, Biochemistry of Insects. Academic Press, New York.
5. Goldsmith, M.R. and František Marec, 2010, Molecular Biology and Genetics of the Lepidoptera. CRC Press Taylor and Francis Group, Broken Sound Parkway NW, USA.
6. Govindan Bhaskaran, Stanley Friedman and Rodriguez, J.G., 1981, Current Tropics in Insect Endocrinology and Nutrition. Plenum Press, New York and London.
7. Morohoshi, S., 2000, Development Physiology of Silkworms. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
8. Saxena, A.B., 1996, Hormones of Insects. Anmol Publications Pvt. Ltd., New Delhi. 9. Sturnikov, V.A., 1976, Control of Silkworm Development and Sex. MIR Publishers, Moscow.
10. Wigglesworth, V.B., 1956, Insect Physiology. 5th Edn., Rev. Methuen, London.

Water Management 2 (1+1)

Objectives

1. To study the fundamental concept about scientific management of irrigation water to achieve higher water productivity.
2. This course is aimed at acquainting the students about the fundamental principles of water management along with various irrigation practices at the field level.

Theory

1. Introduction - definitions, objectives of irrigation and water management, importance of irrigation water, terminologies used in water management and irrigation. History of irrigation in India.
2. Water resources - distribution of water resources, rainfall, reservoirs and tanks, underground water resources, irrigated area in India and Karnataka under the tanks, reservoirs and wells and hydrological cycle.
3. Exploitation of Water Resources - dams, canals, underground, lift irrigation and waste water use systems.
4. Soil water relations - physical nature and characteristics of soil - adhesion, cohesion, capillarity, porosity, bulk density and particle density; effective root zone depth; nature of soil water - hygroscopic, capillary and gravitational water, soil moisture constants, infiltration, expression of soil moisture, soil moisture tension and potentials, expression of soil moisture and their mutual relations, hysteresis, hydro dynamics, assessment of soil moisture by directs methods - gravimetric, volumetric, rapid moisture meter and sulphuric acid method; Indirect methods – tensiometer, gypsum block/ resistance block meter and neutron moisture meter.
5. Plant Water Relations - importance of water in plants, critical stages, effects of excess and deficit moisture on plant growth and water availability and nutrient uptake.
6. Assessment of Water Requirement (WR) - components and components of water requirement - water supplied and water demand, factors influencing water requirement, methods to estimate water requirement - lysimeter, Estimation of ET losses, soil moisture depletion, field experimentation technique, water balance method, drum culture technique, expressions of water requirement.
7. Methods of irrigation - classification, principles, suitability, advantages and disadvantages of surface irrigation methods - flooding, border strip, check basin, ridges and furrow and sub-surface irrigation methods.
8. Sprinkler irrigation method - types of sprinkler irrigation, components, advantages and disadvantages, water distribution pattern and wetting area based on wind speed.
9. Drip irrigation method- differences between sprinkler and drip irrigation methods, types of drip irrigation, components, advantages and disadvantages, water distribution pattern, pitcher irrigation, cablegation, fertigation and suitability of irrigation methods.
10. Irrigation efficiency - conveyance, application of water, storage of water in soil profile, distribution of water, Water Use Efficiency (WUE) - types and methods to improve WUE.
11. Assessment of Irrigation Requirement (IR) - meaning, net irrigation requirement, gross irrigation requirement and relationship between IR and WR.

12. Quantitative estimation of irrigation water - units of water measurement - direct methods - volume time relation, velocity area, tracer method, current meter, coordinate method. Indirect methods - weirs, orifices and parshall flume, duty of water.
13. Suitability of land water for irrigation – Suitability of land – Physical assessment: texture, water holding capacity, non-capillary pores and permeability, degree of slope, direction of slope, depth of water table. Chemical assessment: soluble salt content, exchangeable sodium, pH. Quality of irrigation water - total soluble salts, sodium adsorption ratio; effects of poor quality of water on crop performance, Irrigation management in problematic areas – poorly drained area, saline and alkaline lands.
14. Scheduling of irrigation - definition, approaches to scheduling - Feel and appearance method, plant / crop indices, indicator plants, critical stage approach, soil moisture depletion approach, IW / CPE ratio approach, stress degree day (SDD) concept.
15. Irrigation control structure and water conveyance methods - unlined and lined open channels, pipes, drop structures, check gates, chute spillways, turn outs, flumes and culverts.
16. Irrigation practices for some important crops - paddy, closed and wide spaced crops, plantation and orchard crops and nurseries, suitable irrigation practice for different methods of mulberry cultivation.
17. Drainage - surface and sub-surface methods.

Practical

1. Soil moisture determination by direct methods
2. Study and installation of tensiometer
3. Study and installation of gypsum block resistance moisture meter
4. Determination of bulk density
5. Determination of maximum water holding capacity
6. Determination of field capacity
7. Determination of permanent wilting point
8. Determination of infiltration rate
9. Study of capillarity in soil
10. Study of methods of water flow measurement
11. Study and use of weirs and orifices
12. Study and use of parshall flume
13. Study of surface and sub-surface irrigation methods
14. Study of sprinkler irrigation
15. Study of drip irrigation
16. Study of water requirement calculation for mulberry
17. Study of on-farm irrigation structures
18. Study of drainage structures
19. Practice of numerical examples and conversions.

Suggested readings

1. Irrigation and Water Management - Mukund Joshi and Prabhakar Setty T.K. 2013, Kalyani Publishers.
2. Irrigation Agronomy - Reddy, S.R. 2016, Kalyani Publishers.
3. Irrigation Management - Darra, B.L. and Raghuvanshi, C.S. 1990, M/S Atlantic Publishers and Distributors.
4. Irrigation Water Management: Principles and Practices - Dilipkumar Mujumdar, 2014, Prentice Hall India Learning Private Limited.
5. Irrigation: Theory and Practice - Michael, A.M., 2007, Vikas Publishing House Pvt. Limited.
6. Agricultural Water Management - Premjit Sharma, 2008, Daya Publishing House.

Agricultural Statistics 2 (1+1)

Objective

To impart knowledge about the basic concepts of statistics and familiarize the students about application of statistics in the field of Agriculture.

Theory

Introduction to Statistics and its Applications in Agriculture, Classification and Frequency Distributions of Data, Diagrammatic Representation of Data: Bar and and Pie diagrams, Graphical Representations of Data: Histogram, Frequency Polygon, Frequency curve and Cumulative frequency curve (Ogives). Measures of Central Tendency: Concepts and and Definition, Characteristics of ideal Average, Arithmetic Mean, Median, Mode, Quartiles, Deciles and and Percentiles (both for Ungrouped and Grouped data), Geometric Mean and Harmonic Mean (Ungrouped data). Measures of Dispersion: Concepts and and Definition, Types of Measures of Dispersion: Range, Quartile deviation, Absolute Mean Deviation from mean and median, Standard Deviation and Variance, and Co-efficient of dispersion (both for Ungrouped and Grouped data). Moments, Measures of Skewness and Kurtosis (both for Ungrouped and Grouped data). Concept of Set Theory: Permutation and and Combinations. Theory of Probability: Concept and and Definition, Addition and Multiplication rules (without proof). Theoretical Probability distributions: Binomial, Poisson and Normal Distribution, their Properties and and Applications.

Simple Correlation Analysis: Definition, Measures of Correlation: Scatter diagram, Karl Pearson product moment and Spearman's rank correlation coefficients and their properties. Simple Linear Regression Analysis: Definition, Fitting of simple linear regression equations Y on X and X on Y, Properties of regression coefficient, interrelation between correlation and regression.

Introduction to Sampling Theory: Sampling versus Complete Enumeration, Methods of Sampling, Type of Sampling- Simple Random Sampling (with and without replacement), Use of Random Number Tables for selection of Simple Random Sample, Concept of Sampling distribution and standard error, Concept of systematic, stratified and cluster sampling along with their advantage and disadvantages.

Test of Significance: Introduction, Null and Alternative hypothesis, Types of Errors, Level of significance, Degrees of freedom, Critical and Acceptance regions. Large sample tests: Z-Test

for Means - One and Two Sample Means for Known and Unknown population variance. Small sample test: Student t-test for Means - One and Two sample means, Paired t-test and F-test for two population variances. Chi-Square test: Test for Goodness of Fit, Test for independence of attributes for rXc contingency table, 2x2 contingency table with Yates correction, and test for single population variance.

Introduction to Analysis of Variance and its Assumptions, Analysis of Variance for One and Two Way Classification. Concept of design of experiments: Basic Principle of Experimental Design: Randomization, Replication and Local control, Basic Designs: CRD and RCBD their advantages and disadvantages.

Practicals

Construction of Frequency Distribution tables. Diagrammatic presentation of data: Bar diagrams and and pie diagrams. Graphical Representation of Data: Histogram, Frequency polygon, Frequency curve and Cumulative frequency curve (Ogives). Computation of Measures of Central Tendency: Arithmetic Mean, Median, Mode, Quartiles, Deciles and and Percentiles (both for Ungrouped and Grouped data), Geometric Mean and Harmonic Mean (Ungrouped data). Computation of Measures of Dispersion: Range, Quartile deviation, Absolute Mean Deviation, Standard Deviation and Variance and Co-efficient of dispersion (both for Ungrouped and Grouped data). Computation of Moments, Measures of Skewness and Kurtosis (both for Ungrouped and Grouped data), Problems on permutation and combination. Problems on Simple Probability, Addition and Multiplication rules. Computation of probabilities using Binomial, Poisson and Normal Distributions. Computation of Correlation Coefficient: Karl Pearson product moment and Spearman's rank correlation coefficients. Fitting of Simple Linear Regression Equations Y on X, and X on Y. Use of Random Number Tables for selection of Simple Random Sample. Problems on Large sample tests: Z-Test for Means - One and Two sample means for known and unknown population variance. Problems on Small sample tests: Student t-test for Means - One and Two sample means, Paired t-test, and F-test two population variances. Problems on Chi-Square test: Test for Goodness of Fit, Test for independence of attributes for rXc contingency table, 2x2 contingency table with Yates correction and test for single population variance. Problems on Analysis of Variance for One and Two Way Classified data. Problems on CRD and RCBD.

Suggested readings

SN	Title of the Book	Authors
1.	Fundamentals of applied statistics	Sultan Chand and Sons
2.	Statistical methods for agricultural field experiments	Vijay Katyal and B. Gangawar
3.	Agricultural statistics in India	P. C. Bansil
4.	Applied statistics	Dr. R. Gangai Selvi and Dr. C. Kailasam
5.	Statistical methods	A. Majumder and P. K.Sahu
6.	Handbook of agricultural statistics	Dr. S. R. S.Chandel
7.	A Textbook of Agricultural statistics	R. Rangaswamy

Agricultural Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade.
2. To analyze the factors influencing supply and demand in agricultural markets.
3. To explore different marketing channels and strategies in agriculture.
4. To examine the role of government policies and regulations in agricultural markets.

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, New Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products. Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing. Pearson Prentice-Hall.
6. Lekhi, R.K. and Jogindr, Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India. Kitab Mahal, New Delhi.
8. Pandey, Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing. International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management. Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3(2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture.
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture.

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for Creating, Editing and Formatting a document. Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions. Database: concepts and types, creating database, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/C++, Concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, input-output files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in

Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS-EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri-information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan. Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K et *al*. Jain Brothers Publication.

SEC-IV

Value Addition in Sericulture 2 (0+2)

Objectives

1. To make the students aware about all seri-by-products and its utilization and also entrepreneurship development thus making sericulture as one of the most profitable agro-enterprises.

2. To understand the best utilization of by-products generated at each stage of sericultural activity and their value addition for generating additional income. Making them good entrepreneurial managers in sericulture by exploring the vast entrepreneurial opportunities to make sericulture as one of the profitable and sustainable enterprises.

Practicals

Importance and scope of by-product utilization in sericulture, Value addition during host plant cultivation: kisan nursery, composting, vermicomposting, bio-digester, bio gas production, livestock production, pisciculture, mushroom cultivation. Mulberry as feed for poultry, piggery and other livestock's. Use of mulberry fruits in preparation of jam, jelly and wine. Value addition during silkworm rearing –silkworm litter as livestock feed; as an organic manure, raw material for biogas production, mushroom culture, poultry feed, fish feed, silkworm excreta: chlorophyll extraction. Pupal oil extraction and its uses, pupal powder as animal feed and manure. Flimsy cocoons and waste cocoons for spun silk production and quilting purpose. Silkworm pupa in human consumption-commercialized products and locally prepared dishes. Preparation of handicrafts, toys, wall plates, garlands, greeting cards, etc., from pierced/ cut cocoons. Sericin for medicine, cosmetics, artificial membranes and plastic industry and other uses of silk.

Suggested readings

- Anonymous, 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Bernard, P. Corbman, 1983, Textiles: Fiber to Fabric. 6th Edition, Mc. Graw Hill International Editions, Home Economic Series, Singapore, p. 594.
- Dandin, S.B. and Gupta, V.P., 2002, Advances in Indian Sericulture Research. CSR&TI, Mysore.
- Dandin, S.B., Jayant, Jayaswal and Giridhar, K (Eds.), 2003, Handbook of Sericulture Technologies. CSB, Bengaluru.
- Govindan, R., Chinnaswamy, K.P., Krishnaprasad, N.K. and Reddy, D.N.R., 2000, Non-Mulberry Sericulture, Silk Technology and Sericulture Economics and Extension. Vol. 3– Proceedings of NSTS – 1999. UAS, Bengaluru.
- Sanjay, Sinha, 1990, The Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Ullal, S.R. and Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. CSB Bengaluru.

Entrepreneurship and Business Development in Sericulture 2 (0+2)

Objectives

1. To be able to understand the entrepreneurial opportunities in sericulture.
2. Enables them to understand the resource management in various activities of sericulture for earning more profit.

Practical

Concept of entrepreneur, Entrepreneurship development, Characteristics of entrepreneurs; SWOT analysis and and achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneurial development process; Import, export and international issues; Business leadership

skills; Developing organizational skill (controlling, supervising, problem solving, monitoring and and evaluation), Developing managerial skills, Business leadership skills (Communication, direction and motivation skills), Problem solving skill, Supply chain management and Total quality management, Project planning formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise. Entrepreneurship development in different areas of Sericulture: Entrepreneurship development in mulberry cultivation - kisan nursery, composting, vermicomposting, bio-digester, bio-gas production, livestock production, mushroom cultivation and silage production. Entrepreneurial development in silkworm-egg production, Chawki rearing and cocoon production. Entrepreneurship development in silk reeling and post reeling activities: Entrepreneurship development in silk reeling – establishment of reeling units, twisting and dying units, weaving units. Entrepreneurship development in seri-inputs, manufacture/ production, marketing/ custom hiring of sericulture material/equipment.

Value addition to by-products in sericulture: Value addition to mulberry- mulberry as fuel, green manure, fodder, live fencing material, wind breaks. Mulberry fruits and their use in pickle, jam, jelly, beverage/wine preparation. Mulberry as medicine, mulberry in agriculture and sports industry, mulberry in biogas production, mulberry as shade and avenue tree. Processing of mulberry leaves for tea preparation and food products. Medicinal value of mulberry. Value addition during silkworm rearing –silkworm litter as livestock feed; as an organic manure, raw material for biogas production, mushroom raising, poultry feed, fish feed, silkworm excreta in cosmetic industry. Silkworm in human consumption. Value addition to by-products of silk reeling: Pupal oil extraction and its uses, pupal powder as animal feed and manure. Flimsy cocoons and waste cocoons used as raw material in spun silk industry and quilting purpose. Silkworm pupa in human consumption-commercialized products and locally prepared dishes. Preparation of handicrafts, toys, wall plates, garlands, greeting cards, etc., from waste cocoons. Sericin in medicine, cosmetics, artificial membranes and plastic industry and other uses of silk.

Suggested readings

1. Anonymous. 2002. Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
2. Anonymous. 2002. Colours from Nature – Silk Dyeing Using Natural Dyes. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
3. Bernard P. Corbman. 1983. Textiles: Fiber to Fabric. 6th Edition. Mc. Graw – Hill International Editions, Home Economic Series, Singapore, p. 594.
4. Charles J. Huber. 1929. The Raw Silk Industry of Japan. The Silk Association of America, Inc., New York.
5. Dandin S.B. and Gupta V.P. 2002. Advances in Indian Sericulture Research. CSR&TI, Mysore.
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9. Sinha S. 1990. The Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.

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Journals

- Bulletins of Sericultural Experimental Station – Suginami, Tokyo, Japan.
- Journal of Sericultural Science of Japan – Sericultural Experimental Station, Wade, Suginami-ku, Tokyo, Japan.
- Sericologia – ISC, Bengaluru.
- Indian Journal of Sericulture – CSR and TI, Mysore.
- Journal of Sericulture and Technology – NASSI, Bengaluru.
- Indian Silk – Central Silk Board, Bengaluru.
- Bulletin of Indian Academy of Sericulture - Bhubneswar, Odisha.
- Reshme Krishi (Kannada) – Department of Sericulture, Government of Karnataka, Bengaluru.

Websites

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/documents/2019/tender%20KC.pdf
- www.tnau.ac.in/
- www.csrtimys.res.in/

SEMESTER - V

S. No.	Course Title	Credit Hours
SCI 311	Silkworm Breeding	3 (2+1)
SCP 311	Vanya Sericulture	2 (1+1)
SSC 311	Fundamentals of Soil Science	2 (1+1)
AEX 311	Fundamental of Extension Education	3 (2+1)
SHP 311	Mechanization in Sericulture	2 (1+1)
SCI 312	Seri Biotechnology	2 (1+1)
SPS 311	Physics and Chemistry of Fibres	2 (2+0)
CPH 311	Fundamentals of Crop Physiology	2 (1+1)
AMT 311	Introduction to Agrometeorology	2 (1+1)
PBT 311	Essentials of Plant Biochemistry	2 (1+1)
	Educational and Study tour (2 weeks)	0+2 Non-gradial
	Total	**22(13+9)**

Silkworm Breeding 3 (2+1)

Objectives

1. To study the fundamental concept about silkworm races, silkworm breeding and strategies for future sericulture development.
2. To study the concept of non-conventional silkworm breeding methodology and skill development in germplasm management.

Theory

1. History of silkworm breeding in Japan, China and and India, Origin and differentiation of silkworm breeds, Genealogy of silkworm races, CSR breeds and Hybrids: Characters and requirements for cocoon production, Analysis of accomplishment of silkworm breeding in India andcauses for non exploitation of native silkworm breeds
2. Principles and objectives of silkworm breeding, Hardy Weinberg's Law of Equilibrium of gene and genotype frequencies, Factors disturbing the equilibrium in random populations: Migration, Mutation, Random drift, Selection and Inbreeding, Systems of mating: Random mating, Genetic assortative mating, Genetic dissortative mating, Phenotypic assortative mating and Phenotypic dissortative mating, Objectives of silkworm breeding
3. Activities of silkworm Breeding Program: Creation of variation, Selection, Evaluation, Multiplication and Distribution
4. Maintenance of silkworm germplasm bank: Definition of Germplasm, Importance of maintenance of silkworm germplasm bank/station, Objectives of germplasm station, Activities of germplasm stations, Collection: Definition, Criteria/Procedure for collection of germplasm, Proforma for collection of silkworm breeds, Maintenance of germplasm: Care taken during maintenance, Rearing schedule, Incubation andBlack boxing, Pattern of Brushing, Method of rearing, Selection of cocoons, Egg Production, Passport Description of Germplasm: Name and Number of the Accession/Genotype, Donor, Place of Origin, Classification/Category of germplasm based on origin (Indegenous, Exotic) andneed (Breeds in current use, Obsolete breeds, Breeding material, Other collection)
5. Maintenance and multiplication of silkworm breeds/stocks, Maintenance of silkworm breeds/ stocks - Procedure for Multivoltines and Bivoltines and Maintenance of Breeder's stock, Maintenance of Parental stocks, 3- tier multiplication of parental stocks of silkworms
6. Genetic Basis of silkworm breeding program s, Hybridizarion: Meaning and Objectives, Types and Pre-requisites and Procedure/Steps in silkworm Hybridization Program, Choice of parental material, Crossing and hybridization, Precautions during hybridization, Concept and handling of filial generations (F_1), Handling of Second filial (F_2) and subsequent generations: Pedigree method, Mass/bulk method, Comparison of Pedigree and Mass/Bulk Methods, Consequences and problems in hybridization. Preserving the variability, Minimizing Inbreeding depression
7. Heterosis breeding: Heterosis, Meaning of Heterosis, Effects of Heterosis (Biological, Physiological), Classification of Heterosis, Causes of Heterosis, Biochemical basis. Breeding methods to exploit Heterosis, Measurement of Heterosis: Relative Heterosis, Heterobeltiosis, Standard Heterosi. Commercial exploitation of Heterosis and manifestation of Heterosis
8. Silkworm Improvement through Selection Breeding, Mass selection/Bulk Method: Definition, Procedure of mass selection, Merits and demerits. Pureline selection: Definition, Characters of

pureline, Uses of the pureline, Procedure for pureline selection, Advantages and disadvantages of pureline selection. Back cross (BC) breeding: Definition of Backcross, Requirements for BC breeding program, Application of BC method, Genetic consequences of BC method, Procedure for BC method and Merits and demerits of BC and a few accomplishments. Line breeding: Definition of line breeding and inbreeding, Criteria for line breeding, Procedure for Line/inbreeding and Effects of line/inbreeding

9. Parthenogenesis in silkworms: Definition and history, Classification of parthenogenesis, Methods of induction of parthenogenesis, Characteristic features of parthenogenetic individuals
10. Mutation breeding in silkworm improvement: Definition and historical account of mutation breeding, classification of mutations, mutagens and their classification, effects of mutagens, molecular basis of mutations, mechanism of action of mutagens, procedure for mutation breeding to improve polygenic traits in silkworms, handling mutated population and methods of measurement of mutation frequency and application, limitations and achievements of mutation breeding
11. Polyploidy breeding in silkworm improvement: Definition, occurrence and origin of polyploids, Types of polyploids, Production of polyploids in silkworms and characters of polyploids
12. Breeding for stress tolerance (Biotic: Disease and Abiotic: Temperature) in silkworms: Definition of disease, Disease development, Concept of disease escape and disease resistance, Mechanism of disease resistance: Mechanical, Hyper sensitivity, Antibiosis, Nutritional, Genetic basis of disease resistance and Approaches for disease resistance breeding in silkworms
13. Sex limited breeding in silkworm, *Bombyx mori* L. Techniques for breeding of auto sexing races in silkworms, Concepts of Breeding of non-mulberry silkworm, Authorization of silkworm breeds and their hybrids, AISRCC (All India Sericulture Research Co-ordination committee) norms of authorization, JICA (Japanese International Co-operation for Agriculture) Race Authorization committee

Practicals

1. Study of breed characteristics of mulberry and non-mulberry silkworm
2. Procedure and maintenance of silkworm germplasm bank
3. Procedure for hybridization in silkworms
4. Assessment of variability (ANOVA)
5. Genetic analysis of qualitative and quantitative traits
6. Estimation of heterosis. Diallel (partial and complete) and three-way cross analysis
7. Line X Tester analysis

Suggested readings

1. Mal Reddy N and Kalpana G V (2005). Silkworm Breeding and Genetics, Central Silk Board, Bengaluru.
2. Dilip De Sarkar (1998). The Silkworm - Biology, Genetics and Breeding. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Silkworm Breeding and Genetics - Dr. H K Basavaraj, Dr. S K Ashwath, Dr. N Suresh Kumar.

4. Sreerama Reddy G (Ed.) (1998). Sikworm Breeding. Oxford and IBH Publishing Co Pvt. Ltd., New Delhi and Calcatta.
5. Tazima Y (1964). Genetics of Silkworm. Academic Press, London.

Vanya Sericulture 2 (1+1)

Objectives

1. To enlighten about various types of silk producing insects viz., Tasar, Eri and Muga and their production techniques. This highlights wild rearing *in-situ* in forest area and also semi domestication of wild non-mulberry silks.
2. To provide basic and applied aspects of non-mulberry sericulture. This course will approach multi-disciplinary perspective, it aims to equip students to identify, evaluate and explore new species of sericigenous insects to address the tribals self employment program .

Theory

1. Introduction to vanya sericulture- Importance of vanya silks
2. Global production of vanya silks, their scope and impact on the socio-economic conditions of tribal's. Status of vanya silks in India- Production trends
3. Distribution of Vanya Silk Yielding (Sericigenous) Insects and Non Insects and their Classification Plant Origin- Silk Cotton Fiber and Floss Silk, Animal Origin - Insect origin- Commercially Exploited- Tasar, Eri and Muga, Insect origin – Commercially less Exploited – Anaphae, Fagara, Coan, Non-insect origin – Mussel and Spider silk. Different types of votinism of tropical and temperate tasar, eri and muga silkworms– Univoltine, Bivoltine, Trivoltine and Multivoltine. Characteristic features of different stages of tropical and temperate tasar, eri and muga silkworms - Egg, Larva, pupa, cocoon and adult.
4. Traditional methods of tropical and temperate tasar silkworm rearing – traditional rearing practices by the tribals Improved methods of tropical and temperate tasar silkworm rearing. Indoor rearing (Chawki silkworm) – Bottle rearing, Picture rearing, Pit rearing, Box rearing. Advantages and disadvantages of different indoor rearing techniques. Outdoor rearing – Nylon net enclosure method, Maintenance of outdoor rearing – Feeding and its frequency, Moulting, and mounting management and care during Moulting and mounting and Harvesting of cocoons
5. Egg production technology of topical and temperate tasar silkworms Selection of seed cocoons, Emergence of moths and Synchronization, Pairing and de-paring of moths - Different techniques, Oviposition and care during oviposition, Handling of eggs after egg laying – collection of eggs, washing, drying, packing and mother moth examination
6. Eri silkworm rearing Traditional eri silkworm rearing practices, Improved methods of eri silkworm rearing – Bunch rearing and tray rearing, Maintenance of rearing – Feeding and its frequency, bed cleaning and methods, spacing of worms, Moulting and mounting management and care during Moulting and mounting, Methods of eri silkworm mounting – Bamboo basket, split bamboo, Jali and mat mounting and Harvesting of cocoons
7. Egg production techniques in eri silkworm Selection of seed cocoons, Emergence of moths and Synchronization, Pairing and de-paring of moths - Different techniques, Oviposition and care during oviposition, Handling of eggs after egg laying – collection of eggs, washing, drying, packing and mother moth examination

8. Traditional methods of muga silkworm rearing Traditional muga silkworm rearing practices, Improved methods of muga silkworm rearing – outdoor rearing techniques, Maintenance of rearing – Feeding and its frequency, Moulting and mounting management and care during Moulting and mounting and Harvesting of cocoons
9. Egg production techniques in muga silkworm Concept of Pre-seed and seed crop in muga culture, Selection of seed cocoons, Emergence of moths and Synchronization, Pairing and de-paring of moths - Different techniques, Oviposition and care during oviposition, Handling of eggs after egg laying – collection of eggs, washing, drying, packing and mother moth examination
10. Natural enemies and other problems in vanya silk cocoon production Insect and non-insect pests of vanya silkworm and their management, Diseases of vanya silkworm and their management, Other problems in vanya sericulture sector – natural calamities, forest policies, marketing of cocoons etc.,
11. Marketing of vanya silk (Tasar, Eri and Muga) products (Cocoon, raw silk and silk fabrics)
12. Economics of Tasar, eri and muga culture
13. Recent Developments in Non-Mulberry Sericulture New Projects, Other Agencies Involved In Vanya Sector – NGOs Etc., Value Addition to Non-Mulberry Sericulture By-products.

Practical

1. Study on Vanya silkworms
2. Study on Insect and Non Insect Sericigenous Species
3. Study of life stages of eri silkworm, tasar and muga silkworms
4. Host plants of eri silkworm and their pests and diseases
5. Study on food plant production technology of Eri Silkworm *Samia cynthia ricini*
6. Grainage operations in *Samia cynthia ricini* Boisduval
7. Rearing of Eri Silkworm *Samia cynthia ricini* on Primary Host Plants and diseases and pests of eri silkworm
8. Spinning, harvesting and grading of eri silk cocoons
9. Economics of ericulture
10. Host plants of tasar silkworms and their pests and diseases
11. Study on food plant production technology of tasar silkworm
12. Study of Rearing Tasar Silkworm on Primary Host Plants and Pests and Diseases of Tasar Silkworm
13. Host plants of muga silkworms and their pests and diseases
14. Study on Host Plant production technology of Muga Silkworm
15. Study of Rearing Muga Silkworm Antheraea assamensis and Pests and Diseases of Muga Silkworm

Suggested readings

1. Jolly, M.S., Sen, S.K. and Ahsan, M.M., 1974, Tasar culture. Ambika Publishers, Bombay.
2. Jolly, M.S., Sen, S.K., Sonwalkar, T.N. and Prasad, G.K., 1979, Sericulture Manual.

4. Non-Mulberry Silks. Agriculture Service Bulletin, FAO, Rome.
3. Sannappa, B., Jayaramaiah, M., Govindan, R. and Chinnaswamy, K.P., 2002, Advances in Ericulture. Seri Scientific Publishers, Bengaluru.
5. Sarkar, D.C., 1980, Ericulture in India. Central Silk Board, Bengaluru.

Fundamentals of Soil Science 2 (1+1)

Objectives

1. To enable the students to familiarize the soil formation and its properties
2. To study the soil pedolgy and soil physics

Theory

1. Soil Science: definition, introduction, importance, scope and branches
2. Soil: definition, Soil a natural body, edaphalogical and pedological concepts of soil, components of soil
3. Minerals: definition, occurrence, classification of minerals based on abundance, specific gravity, mode of origin and chemical composition, study of silicate and non-silicate minerals (types and their composition)
4. Rocks: definition, formation, occurrence and classification of rocks based on mode of origin. Igneous rocks, Sedimentary rocks and Metamorphic rocks, their classification
5. Weathering of rocks and minerals: definition, types - physical, chemical and biological weathering, factors influencing weathering, products of weathering, weathering sequence
6. Soil formation: factors of soil formation, active factors like climate, organisms and passive factors like parent materials, topography and time
7. Pedogenic processes of soil formation: basic/ fundamental processes and specific pedogenic processes
8. Soil profile: master horizons, transitional horizons and subordinate horizons
9. Soil physical properties: Soil texture- definition, soil separates (USDA and ISSS) and their properties. Particle size analysis – Stoke's law; derivation, assumptions and limitation of Stoke's law. Textural classes
10. Soil structure: classification based on types, class and grade, importance, mechanism of aggregate formation, factors affecting soil structure and evaluation of soil structure. Management of soil structure
11. Soil density: particle density, bulk density; their relationships, factors influencing soil density and importance
12. Soil porosity: definition, types of pores, factors affecting porosity and importance
13. Soil colour: Attributes (hue, value and chroma), importance, factors affecting soil colour
14. Soil consistency: forms (Hard, soft, plastic and sticky consistency), factors affecting consistency, Atterberg's limits, and significance
15. Soil air: composition, importance, mechanism of gaseous exchange and management
16. Soil temperature: Source, amount, factors influencing soil temperature, flow of heat, thermal properties of soil and its importance/management in plant growth

17. Soil water: classification, soil moisture constants, movement and availability of soil water, infiltration, percolation and hydraulic conductivity
18. Soil Organisms: Macro and Microorganisms (Beneficial and Harmful organisms)
19. Soil survey: types, methods and purpose of soil survey
20. Soil classification: USDA system of classification (Soil taxonomy); salient features, structure of soil taxonomy, formative elements and their meaning, epipedons, endopedons, soil moisture and soil temperature regimes, keys to soil orders and salient characteristics of Inceptisols, Entisols, Alfisols and Vertisols.
21. Soils of India and Karnataka

Practical

1. Study of silicate minerals
2. Study of non-silicate minerals
3. Study of igneous rocks
4. Study of sedimentary rocks
5. Study of metamorphic rocks
6. Study of soil sampling tools and collection of representative soil samples
7. Study of soil profile
8. Determination of soil density, moisture content and porosity
9. Study of soil texture by feel and bouyoucos method
10. Studies of capillary rise phenomenon of water in soil column and water movement in soil
11. Determination of soil colour
12. Demonstration of heat transfer in soil
13. Study of soil map

References

1. Arun Kumar Saha, 2004, Textbook of Soil Physics, Kalyani Publishers, New Delhi.
2. Baruah T.C. and Barthakar, H.P., 1997, A Textbook of Soil Analysis, Vikas Publishing House Pvt Ltd, New Delhi.
3. Brady, N.C. and Weil, R., 2001, Nature and Properties of Soil, 13th edition, Macmillan Co., New York.
4. Dipak Sarkar, 2003, Fundamentals and Applications of Pedology, Kalyani Publishers, New Delhi.
5. Dilip Kumar Das, 1996, Introductory Soil Science, Kalyani Publishers, New Delhi.
6. Ghildayal, B.P. and Thripathi, R.P., 1987, Soil Physics, Wiley Eastern Ltd, New Delhi.
7. Sekhon, G.S., 2002, Fundamentals of Soil Science, ISSS, IARI, New Delhi.
8. Sehgal, J., 1996, Pedology, concepts and applications, Kalyani Publishers, New Delhi.

Fundamentals of Extension Education 3 (2+1)

Objectives

1. To enable the students to understand the importance of extension education and different rural development programs.

2. To understand the concept of Extension education and rural development programs.

Theory

1. Education: Meaning, definition and and types; Extension education - meaning, definition, scope and process
2. Objectives and principles of extension education
3. Extension program planning – Meaning, Process, Principles and steps in program development
4. Extension systems in India: Extension efforts in pre-independence era (Sriniketan, Marthandam, Firka development Scheme, Guragaon Experiment) and Post-independence era (Etawah Pilot Project, Nilokheri Experiment)
5. Agriculture development programs launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP).
6. New trends in agriculture extension: Privatization of extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems.
7. Rural development: Concept, meaning, definition; various rural development programs launched by Govt. of India. Community Development- meaning, definition, concept and and Principles, Philosophy of C.D.
8. Rural leadership: Concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions
9. Monitoring and evaluation: Concept and definition, monitoring and evaluation of extension programs; transfer of technology: concept and models, capacity building of extension personnel.
10. Communication: Meaning, definition, Basic elements of communication and their characteristics, Principles and functions of communication. Communication models- Aristotle, Shanon Weaver, Berlo's, Sachramm, Leagan's, Rogers and Shoemaker and Lasswell model. Types and barriers to communication. Scope and importance of communication
11. Diffusion and adoption of innovations - Concepts and meaning, definition, attributes of innovation, models, adoption process and stages of adoption and factors influencing adoption process. Innovation Decision Process - elements, adopter categories and their characteristics
12. Extension teaching methods- Meaning, definitions, functions and classification
13. Factors influencing the selection of extension teaching methods and combination (Media Mix) of teaching methods. Individual contact methods-farm and home visit, result demonstration, field trials - meaning, objectives, steps, merits and demerits. Group contact methods-group discussion, general meeting, method demonstration, field trips and study tour - meaning, objectives, steps, merits and demerits. Mass contact methods - newspaper, campaign, exhibition, kisan mela, radio and television - meaning, importance, steps, merits and demerits.
14. Application in TOT (New and Social media), Definition, concept, ICAR projects, National demonstrations, ORP, KVKs, Lab to Land program, constraints in TOT, models of transfer of Technology, farming system research extension model, IPM-FFs model, decentralized extension, ATMA model, model developed by IRI New Delhi, farming system research / extension, ICT applications in TOT (New and Social media), media mix strategies.
15. Capacity building of extension personnel and farmers-meaning, definition types of training, difference between capacity building and training, methods of capacity building, different

methods of training, training to farmers, farm women and rural youth FTC and KVK

16. Agriculture Journalism – functions of Journalism, different sources of information and importance of journalism in agricultural development, news and factors influencing effectiveness of news

Practical

1. To get acquainted with university extension system. Group discussion –exercise; handling and use of audio visual equipments and digital camera and LCD projector; preparation and use of AV aids
2. Preparation of extension literature- leaflet, booklet, folder, pamphlet news stories and success stories. Presentation skills exercise; micro teaching exercise
3. A visit to village to understand the problems being encountered by the villagers/farmers
4. To study organization and functioning of DRDA and other development departments at district level
5. Visit to NGO and learning from their experience in rural development
6. Understanding PRA techniques and their application in village development planning; exposure to mass media
7. Simulated exercises on communication
8. identifying the problems fixing the priorities and selecting the most important problem for preparation of a project
9. Developing a project based on identified problem in a selected village
10. Organization of group discussion and method demonstration
11. Visit to KVK/ FTC
12. Planning and writing of scripts for radio and television
13. Audio visual aids, meaning, importance and classification
14. Selection, planning, preparation, evaluation and presentation of visual aids
15. Audio visual aids – meaning, importance and classification
16. Visit to community radio and television studio for understanding the process of program production
17. Planning and preparation of visual aids- posters, charts, overhead projector (OHP), transparencies, power point slides
18. Planning and preparation of agricultural information materials-leaflet, folder, pamphlet
19. New stories and success stories field diary and lab record, indexing, footnote and bibliographic procedure
20. Handling of public address equipment (PAE) system
21. Still camera, video camera and liquid crystal display (LCD) projector
22. Development of schedules, questionnaires and field visits for data collection

Suggested Readings

1. Advi Reddy, A., (1977) Extension Education, Sree Lakshmi Press, Bapatla (A.P).
2. Benor, D. and Baxter, M, (1984), Training and visit Extension. The World Bank Washington.

3. Berlo, D.K., (1960), The process of Communication. Holt, Rinehart Winston Inc., New York.
4. Bhaskaran, S., (2014), Entrepreneurship Development and and Management, Aman Publishing House, Meerut.
5. Debabrata Das Gupta, (2012), AGROBIOS (INDIA), Agro House, behind Nasrani Cinema, Chopasani Road, Jodhpur.
6. Dhama, O.P. and Bhatnagar, (1985), Education and Communication for Development, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
7. M.V., Srinivasa Reddy, (2021), Fundamentals of Agricultural Extension Education, Brillion Publishers, New Delhi.
8. Muthaiah, Manoharan, Arunachalam, R. Agricultural Extension, Himalaya Publishing House, Ramdoor, Mumbai.
9. Ray, G.L., (1991), Extension Communication and Management, Naya Prakash, Calcutta.
10. Rogers, E.M., (2003), Diffusion of Agril. Innovations, Free Press, New York.
11. Sagar Mondal, (2017), Fundamentals of Agricultural Extension Education, Kalyani Publishers, Delhi.
12. Sandhu, A.S., (2003), Agricultural Communication Process and Methods, Oxford and IBH Publishing, Co. Pvt. Ltd.
13. Supe, S.V. (1987), An introduction to Extension Education, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Mechanization in Sericulture 2 (1+1)

Objectives

1. To study the mechanization related to mulberry cultivation and cocoon production and post cocoon production process.
2. To acquire a practical knowledge on primary stage of repair and maintenance of machineries.
3. To study the tillage, intercultural and other machineries used for mulberry cultivation.
4. To study the different machineries/handtools/systems used in rearing house for cocoon production.
5. To acquire a knowledge about machineries/ tools involved in post cocoon production process.
6. To obtain a knowledge about repair and maintenance of machineries.

Theory

Status of farm power in India, Sources, importance and scope of mechanization. Different tillage, intercultural and other machineries used for mulberry cultivation. Different machineries/ handtools / instruments/ systems used in rearing house for cocoon production. Different types of mountages and mounting sheds. Cocoon driers. Cocoon sorting machines-riddling-deflossing machines. Cocoon cooking, brushing machines and Boilers. Filature and cotton basin units. Working of reeling and re-reeling machines, types, suitability and their testing. Silk twisting and throwing equipment. Non-mulberry cocoon reeling machines. Primary repair and maintenance of machineries used for mulberry cultivation.

Practicals

1. Familiarization with operation of tillage, intercultural and other machineries
2. Determination of different measures of mulberry cultivation machineries
3. Operation and installation of systems/ instruments used in rearing house for cocoon production
4. Study of mountages and mounting sheds, revolving mountages- cocoon stifling structures
5. Study the operation of cocoon driers
6. Familiarization with cocoon sorting machines-riddling-deflossing machines
7. Familiarization with cocoon cooking and brushing machines
8. Familiarization and operation of reeling machines
9. Familiarization with cottage basin and filature basins
10. Familiarization with automatic reeling machines, re-reeling machines
11. Familiarization with silk twisting and throwing equipment
12. Familiarization with repair and maintenance of machineries
13. Visit to reeling units

Suggested readings

1. B.B., Bindroo and Satish Verma; 2014. Sericulture Technologies Developed by CSRTI, Mysore (http://www.csrtimys.res.in/sites/default/files/ebooks/2014-1.pdf)
2. Krishnaswami, S.; Narasimhanna, M.N.; Suryanarayan, S.K.; Kumararaj, S.; 1973. Sericulture manual (v.) 2.: Silkworm rearing. FAO Agricultural Services Bulletin (FAO) Eng v. 15(2)
3. Satish, Verma; S.B., Dandin; 2006. Mechanisation in Sericulture. Published by CSRTI, Mysore (http://www.csrtimys.res.in/sites/default/files/ebooks/2006-2.pdf)

Seri Biotechnology 2 (1+1)

Objectives

1. To understand the principles and applications of biotechnology.
2. To provide information on various applications of biotechnology in sericulture.

Theory

Introduction to Biotechnology. Principles and methods of plant tissue culture techniques. Micro propagation in mulberry. Secondary metabolites and their applications. Recombinant DNA technology – Principles and applications in sericulture, PCR Techniques and their types. Restriction Enzymes, Vectors, Host and steps in gene cloning and expression. Transgenic- Methods of Gene Transformation (Agrobacterium and Ballistic Gene gun method). Molecular markers and their application in sericulture. Introduction to Genome Mapping. CRISPR-Cas9 technology and its application in sericulture. Introduction to Bioinformatics. Principles, Methods and Applications of gene sequencing. Gene silencing and its importance in sericulture. BmNPV vector and its applications.

Practical

Requirements for Plant Tissue Culture Lab. Techniques in Plant Tissue Culture- Sterilization Techniques, Plant Tissue Culture Media, Preparation of MS Medium. Micro-propagation in

Mulberry. Genomic DNA Isolation in mulberry and silkworm. Study of Gel Electrophoresis. Study of Polymorphism in PCR based molecular markers. Gene Transformation Techniques- Agrobacterium mediated transformation and Ballistic Gene gun method. An overview of Bioinformatics tools. Visit to Biotechnology Laboratory.

Suggested readings

1. Applications of Biotechnology in Sericulture by Venkatesh Kumar R.
2. Handbook of Agricultural Biotechnology by Dr Rajendra Kumar Yadav
3. Biotechnology Expanding Horizons by B D Singh

Physics and Chemistry of Fibres 2 (2+0)

Objectives

1. To understand the properties of different textile fibres.
2. Able to differentiate between natural and synthetic fibres.

Theory

1. Introduction, History and classification of fibres
2. General properties of fibres and essential properties of fibre forming polymer
3. Common properties of natural fibres – plant, animal and mineral fibres and synthetic/artificial fibre
4. Physical properties of fibres – length, width, ratio, translucency, luster, resiliency, pliability, elasticity
5. Chemical properties of fibres – reaction to acids, alkalies, salts
6. Study of plant based or cellulosic fibres – Cotton, flax/linen, hemp, ramie, sisal, abaca, pina, kapok, coir, jute
7. Study of regenrated cellulosic fibres – Rayon, acetate, triacetat fibres
8. Study of animal or protein fibre – wool, silk, spider
9. Hair fibres – camel, vicuna, Guancco, Llama, Aplaca, mohair, angora, quivit, human hair
10. Minor hair fibres – camel, common rabbit
11. Study of regenerated protein fibre – casein, ardil and vicara
12. Study of mineral and inorganic and and high performance fibres – asbestos – glass fibres, carbon fibres, silicon carbide fibres, stainless steel fibres
13. Study of synthetic fibres – Nylon, polyester, poly acryl, vinylon (poly vinyl) vinilidene chloride, polyethylene, polypropylene, poly urethane

Suggested readings

1. Arindum Basu, 2015, Advances in silk science and technology.
2. Barker, A.F., 1998, Handbook of textiles.
3. Mishra, S.P. 2005, A textbook of fibre scence and technology, A New age International Publishers, p.368
4. Susma Gupta, 2004, Textbook of clothing and textile.

Fundamentals of Crop Physiology 2 (1+1)

Objectives

1. To learn the basic functioning of plants.
2. To understand water and nutrient uptake and functioning mechanisms in plants; mechanism of CO_2 fixation in plants; plant growth and development as influenced by plant growth hormones; mechanism of stress adaptation by plants.

Theory

1. Introduction: Importance of physiology in various fields of agriculture.
2. Plant-water relations: Structure of water, functions and properties of water. Importance of water for plant growth and development. Water movement in plants, concept of diffusion, osmosis and imbibition. Concept of water potential: Definition, components of water potential in plant cell and soils. Water in soil; forms of water in soil and available water. Concepts of water saturation, field capacity, wilting point.
3. Water absorption. Symplastic and apoplastic movement of water in plants. Internal and external factors influencing water absorption in plants. Translocation of water: Theories explaining ascent of sap (water translocation). Soil-plant-atmosphere continuum; Internal and external factors influencing water translocation in plants.
4. Transpiration: Definition, types of transpirations in plants, significance of transpiration; Transpiration in relation to crop productivity. Transpiration ratio. Stomatal physiology: Structure of Stomata, types and stomatal movement. Theories explaining the stomatal movement. Factors affecting transpiration rate. Concept of cavitation. Water use efficiency and its relevance. Water use efficiency in C3, C4 and CAM plants. Anti-transpirants- Definition, different types of Anti-transpirants with examples.
5. Mineral Nutrition: Definition, importance of plant nutrients, Arnon's criteria of essentiality. Classification of essential nutrients based on requirements, Physiological role and Biochemical functions and based on mobility in phloem. Mechanisms of ion uptake: Theories explaining ion uptake, Passive and active ion uptake, membrane transporters and carriers.
6. Photosynthesis: definition, structure of chloroplast and its function. Photochemical and biochemical reactions and their importance for photosynthesis. Mechanism of carbon fixation in C3, C4 and CAM plants. Steps in carbon fixation: Chemo-osmotic theory and ATP production. Kranz leaf anatomy in C4 plants and its relevance. Difference between C3, C4 and CAM pathways. Internal and external factors influencing photosynthesis in plants. Phloem loading and unloading; difference between apoplastic and symplastic phloem loading. Photorespiration; significance and steps involved in photorespiration.
7. Respiration: definition and significance of respiration, structure of mitochondria and its function. Respiratory substrates and Respiratory quotient, types of respiration, Steps in aerobic respiration. Anaerobic respiration/ fermentation. Alternative respiration /pentose phosphate pathway. Cyanide resistance respiration in plants. Internal and external factors influencing rate of respiration in plants. Relationship between respiration, photosynthesis and yield.
8. Plant growth and development: Definition. Plant growth pattern and growth curve. Determinate and indeterminate growth habits. Monocarpic and polycarpic species with examples.

Growth and yield parameters and their measurements; Measurement and Formulae used for determining Leaf Area Index (LAI), Leaf area duration (LAD), Specific leaf area (SLA), Crop Growth rate (CGR), Net assimilation rate (NAR), Relative growth rate (RGR), Harvest Index (HI).

9. Plant growth regulators and Hormones: Endogenous and exogenous (synthetic) growth regulating substances. Discovery and site of synthesis of different plant hormones. Synthetic growth regulating substances, growth retardants, growth inhibitors, pinching agents, male sterility. Importance of plant growth regulators in modulating crop growth. Physiological importance of different plant hormones such as Auxin, Gibberellin, Brassinosteroid, cytokinin, ABA, ethylene etc., Biosynthesis and mode of action of plant hormones, applications of plant growth regulators in agriculture, horticulture and industry.
10. Stress Physiology: Acclimation and adaptation mechanisms. Plants response to stress. Strategies adopted by plants to overcome stress effects. Drought tolerance traits and their relevance.

Practical

1. Preparation of standard solutions, units of concentration and dilution
2. Methods of measuring water status in plant tissue
3. Determination of stomatal frequency and index
4. Measurement of stomatal conductance and transpiration
5. Extraction, separation and quantification of photosynthetic pigments
6. Measurement of water use efficiency at single leaf level
7. Measurement of photosynthetic rate
8. Measurement of respiration rate
9. Measurement of growth and yield parameters
10. Deficiency symptoms of nutrients and their identification
11. Growth hormone bioassay
12. Effect of moisture stress on seed germination and seedling vigour

Suggested readings

1. Advanced Plant Physiology – Malcolm B. Wilkins
2. Introduction to Plant Physiology – William G. HopkinsIntroductory Plant Physiology- Ray Noggle G. and Fritz G. J.
3. Plant Physiology – Robert, M. Devlin and Francis H. Witham
4. Plant Physiology (3rd edition) - Taiz L. and Zeiger E
5. Plant Physiology (4th Indian Edition) - Frank, B. Salisbury and Cleon W. Ross

Introduction to Agrometeorology 2 (1+1)

Objectives

1. Enables the application of meteorological information to agriculture
2. To study the weather and its uses in crop production
3. To learn about climate to enhance or expand agricultural crop production

Theory

1. Agricultural meteorology, meaning, scope and importance in crop production;
2. Earth Atmosphere-composition-vertical layers of atmosphere based on temperature difference;
3. Climate and weather-factors affecting climate and weather, Atmospheric weather variables;
4. Atmospheric pressure, its variation with height;
5. Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze;
6. Solar radiation, Nature and properties, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo;
7. Light, light intensity, quality, direction and duration, effect of light on crop production
8. Atmospheric temperature, temperature inversion, lapse rate, diurnal and seasonal variation in air temperature, Isotherm;
9. Heat unit, definition and its use, heat and cold waves, role of temperature in crop production. Energy balance of earth;
10. Atmospheric humidity, concept of saturation, vapor pressure, Absolute humidity, Relative humidity, Specific humidity;
11. Cloud formation and classification;
12. Condensation, Process of condensation, formation of dew, fog, mist, frost, cloud;
13. Precipitation, process of precipitation, types such as rain, snow, sleet, and hail;
14. Artificial rainmaking. Cold and warm cloud seeding, Monsoon- mechanism and importance in Indian agriculture;
15. Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave;
16. Weather forecasting- types of weather forecast and their uses.

Practical

1. Visit of Agrometeorological Observatory
2. Selection of site for Agrometeorological observatory, exposure of instruments and weather data recording
3. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law
4. Measurement of albedo and sunshine duration
5. Computation of radiation intensity using Bonnel sphere spectrometer
6. Measurement of maximum and minimum air temperatures
7. Tabulation, trend and variation analysis in maximum and minimum temperature
8. Measurement of soil temperature and computation of soil heat flux
9. Determination of vapour pressure and relative humidity
10. Measurement of atmospheric pressure and analysis of atmospheric conditions
11. Measurement of wind speed and wind direction

12. Measurement, tabulation and analysis of rainfall
13. Measurement of open pan evaporation and evapotranspiration
14. Computation of potential and actual evapotranspiration

Suggested readings

1. Climate Science, Naushd Khan and Digvijay Dubey, Bhavya Books, New Delhi
2. Mahi, H.S., 2003, Introduction to Agrometerology, Kalyani Publishers, New Delhi
3. S.R., Reddy, 2016, Principles of Agronomy, Kalyani Publishers, New Delhi
4. Sujay, S.R. and Kapli, S., 2021, Bhavya Books, New Delhi
5. Yellamandareddy, T and Shankar Reddy, G.H., 2016, Principles of Agronomy, Kalyani Publishers, New Delhi

Essentials of Plant Biochemistry 2 (1+1)

Objectives

1. This course aims to provide an in depth understanding of the metabolism of macro and micronutrients and of the role of nutrition in influencing cell growth, development and maintenance of body functions. Students will be able to understand the biochemical pathways in normal and diseased conditions.
2. To understand the relationship of chemical and physiological functions of various specialized cells of the body to their roles in metabolism and nutrition.
3. To describe the major pathways of energy metabolism, how they are regulated, modified during different physiological states and their consequences.
4. To understand the biochemical aspects of nutrients and utilization of nutrients in the body.

Theory

1. Introduction to biochemistry: The plant cell and its sub cellular organelles-nucleus, endoplasmic reticulum, Golgi apparatus, vacuoles, mitochondria, chloroplasts, micro bodies, oleosomes, cytoskeleton, cell wall and their functions.
2. Biomolecular components of plant cells:
    * Carbohydrates - Definition and classification. Monosaccharides - stereochemistry, nomenclature, cyclic forms. Mutarotation, reactions of monosaccharides. Di-andoligo-saccharides. Plant polysaccharides, structure and role.
    * Amino acids and proteins: Importance of proteins in living systems. Diverse roles of proteins. Amino acids, the subunits of proteins. Classification, structures and chemical reactions. Protein amino acids. The peptide bond. Biological role of peptides. Protein classification. Structure of proteins - primary, secondary, tertiary and quaternary structures. Properties of proteins. Denaturation of proteins.
    * Lipids: Classification. Fatty acids - their classification and structures. Chemical properties, Triglycerols, waxes, phospholipids, sphingolipids, terpenes and sterols. Their structures and functions.
    * Enzymes: Classification and nomenclature. Factors that influence enzyme activity. Immobilization and industrial applications.

* Nucleic acids: RNA and DNA. The constituents of nucleic acids, structures of purines and pyramidines. Nucleosides, nucleotides. DNA-its structure. Types of RNA, their characteristics and role. Cloverleaf structure of tRNA.

3. Metabolism of Biomolecules:

An overview of metabolism, catabolism and anabolism-their general characteristics.

A. Carbohydrate metabolism:

* Glycolysis-Pathway of glucose in the cytosolic glycolytic sequence. Energetics of glycolysis.
* TCA cycle-a mitochondrial reaction cycle. Oxidation of Pyruvate via TCA cycle. Energetics of TCA cycle.
* Electron transport and oxidative phosphorylation-the components of the electron transport chain. ATP synthesis coupled to electron transport.
* The pentose phosphate pathway-reactions. Role of pentose phosphate pathway.

B. Lipid metabolism: β-Oxidation of fatty acids and its energetics. Amino acid metabolism: Removal of amino group of amino acids by deamination and transamination. Decarboxylation of amino acids.

4. Secondary metabolites:

* Phenolics: Different classes of phenolics and their functions.

  Polyphenols: the tannins-classification of tannins. Phenolics and tannins as antinutritional factors. Roles of phenolics and tannins in disease/pest resistance of plants.
* Alkaloids: Definition and occurrence of some common alkaloids of plants. Role of alkaloids as defense compounds.
* Terpenoids: Nomenclature, classification and occurrence. Functions of terpenoids. Carotenoids-their distribution and functions in higher plants.

Practical

1. Estimation of total sugars by Phenol-Sulfuric acid method
2. Estimation of protein by Lowry's Method
3. Protein denaturation: Heat, pH, Precipitation of protein with heavy metals
4. Extraction of oil from oil seeds
5. Estimation of crude fat
6. Estimation of iodine number of an oil
7. Estimation of saponification value of an oil or fat
8. Determination of ascorbic acid
9. Determination of chlorophylls
10. Determination of phenols
11. Assay of enzyme
12. Extraction of nucleic acids and quantification
13. Paper chromatography for separation of sugars
14. Quantitative and qualitative determination of sugars

SEMESTER – VI

S. No.	Course Title	Credit Hours
SHP 321	Experimental Techniques in Sericulture Research	2 (1+1)
SPS 321	Silk Throwing Dyeing and Weaving	3 (2+1)
SPS 322	Spun Silk Technology	1 (0+1)
SPS 323	Apparels in Sericulture Industry	1 (0+1)
AMB 321	Agricultural Marketing, Trade and Prices	2 (1+1)
FES 321	Introduction to Agro Forestry	2 (1+1)
BNT 321	Bio Formulation and Nano Technology	2 (1+1)
AEG 321	Renewable Energy in Agriculture and Allied Sector	3 (2+1)
AEC 321	Fundamentals of Agricultural Economics	2 (2+0)
PAT 321	Fundamentals of Plant Pathology	3 (2+1)
	Total	**21(12+9)**

Experimental Techniques in Sericulture Research 2 (1+1)

Objectives

1. To heighten the sericulture knowledge and improve technology.
2. Is to prove a hypothesis or answer a specific question of sericulture by doing step by step research.
3. To address the region specific problem.
4. To solve pest and disease problem in mulberry crop production.

Theory

1. Definition of research and sericulture research. Steps involved in basic research.
2. Development of sericulture research in India and Karnataka.
3. Modern trends, concepts in sericulture research and their impact on productivity: Mulberry improvement (Conventional practices and Modern Genetic Engineering concepts), Silkworm improvement, Other trends in sericulture research (Mulberry based Integrated farming system, Integrated nutrient management and Integrated pest and disease management).
4. Essence of research levels: Level-1, Level-2, Level-3, Level-4 and Level-5.
5. Methods of research: (Scientific method, empherical method, experimental method, statistical method, survey method, case study method and historical method).
6. Review of literature on sericulture research: Pot culture experiments, Animal experiments, Field experiments- varietal, cultural, fertilizer, pesticides, irrigation.
7. Aims and Objectives of laboratory and field experiments: Aims and broad and specific objectives.
8. Selection of site for experiment: Different criteria's to be considered for selection of site, plot size and shape.
9. Sources of variation of experiments.
10. Uniformity trials and interpretation of blocks.

11. Factors considered in fixing treatments and in fitting the experiments: Criteria for choice and priority, Treatment fixing: Reviewing of previous literature, preliminary experiments, Decision of intervals.
12. Different types of experiments-varietal, cultural, manurial, irrigation, weed control, silkworm rearing, Silk worm breeding, grainage, pests diseases and silk technology.
13. Research project and Procedure to prepare research project proposal: Thrust area, background, Concept, introduction, methodology, expected outcome, Practical significance.
14. Preparation of data for scientific papers and presentation of results.
15. Experiments on mulberry and non- mulberry host plants.
16. Short and long duration trials: Long term fertilizer and manurial experiment. Breeding of pest and disease resistant genotypes of mulberry and silkworm breeds.
17. Maintenance of experimental records, Recording of observations, sampling techniques, tabulation, analysis and presentation of results.
18. Scientific photography and preparation of transparencies for slide projector and overhead projector.

Practical

1. Types of laboratories and field experimentation
2. Selection site and land allotment
3. Experiments on grainage
4. Experiments on mulberry silkworm rearing and silk technology
5. Techniques for assessment of damage of pests, diseases and weeds among the host plans of silkworm
6. Assessment of soil fertility before experimentation and plot work
7. Techniques to record observations in mulberry and silkworm, growth and yield analysis of mulberry
8. Methods of measuring leaf area in mulberry
9. Calculations of measure of central tendency and dispersion
10. Analysis of variance techniques in computation of "F" and "T" tables
11. Analysis of data from a Completely Randomized Design (CRD)
12. Analysis of data from Randomized Complete Block Design (RCBD)
13. Analysis of data from Latin Square Design (LSD)
14. Analysis of data from simple Factorial Experiment
15. Analysis of data from split-plot design
16. Practical Examination

Silk Throwing, Dyeing and Weaving 3 (2+1)

Objectives

1. Students are able to understand the whole process of fabric making.
2. Students are able to produce the twisted silk yarn and dyeing the silk yarn/printing on the silk fabric and plain weaving.

Theory

Introduction, Soaking of silk, winding, doubling, twisting, types of twisted yarns, types of twisting machines – up twister, two for one twister, steaming, warping- methods of warping – beam and sectional warping, ball warping. Weft yarn package – weft yarn by natwa winding, pirn winding, weft package/pirn. Wet processing – at yarn stage and at fabric stage. Degumming (boil off) of silk – soupling, Ecru silk. Bleaching of silk, methods, Dyeing of silk – dyeing of silk with acid dyes, metal complex dyes, reactive dyes, vinyl sulphone dyes, direct dyes. After treatment with dyei. Washing, acid treatment, hydro extractor, drying, skeining and packing. Silk printing for fabric. Classification of printing styles-silk printing styles. Printing tools and devices and quality control in printing. Silk finishing-mechanical: dry and wet, chemical finishing. Application of the finish. Finishes for the functional products. Weaving – handloom and powerloom weaving. Handloom weaving – types frame loom and pit loom, drawing – in and denting, heald shaft, heald count, reed, reed count, systems of counting, gaiting and piercing, yarn arrangement over the heald frames – straight, pointed and skip draft. Basic mechanisms of interlacing – primary, secondary and auxillary motions. Shedding – different types of shedding mechanisms-dobby, tappet (treadles) and jacquard. Types of shed. Picking mechanisms, beat up mechanism, warp let off and take up motions. Warp stop motion and filling stop motion, warp protector motion, transverse fabric control. Selvedges. Fabric structure- weave, thread densities of warp and weft, the coarseness and fineness of warp and weft yarn, the waviness of warp and weft, Basic fabric properties. Woven fabric design-Plain weave, ornamentation of plain cloth, warp rib weave, weft rib weave and Basket (matte weave) - 2 × 2, 3 × 3 or 4 × 4. Twill weave – 2/1 or ½, 2/2 3/3 4/4. Satin and sateen weaves. Concept of fabric quality, perspectives of fabric quality and fabric defects. Importance of crimps, Silk sarees of different weaving clusters, crepe fabrics, georgette, chiffon, soft silk fabrics, organza, tafetta, habutai and tabby. Power loom shuttle and shuttle less looms (gripper and jet-picking mechanism).

Practical

Silk throwing-winding, doubling, twisting-types of twisting. Steam setting of twisted yarn. Warping and yarn winding. Degumming of silk; Methods of degumming, water quality for wet processing. Bleaching and dyeing, classification of dyes, factors influencing dyeing, preparation of dye and methods of dyeing. Study of different types of looms and their characteristics. Printing and methods of printing –block and screen printing. Weaving-loom and its structure, different types of looms, arrangement of yarn for simple weaving and design weaving. Textile Designing, Motifs for weaving and textile printing, silk / fabric finishing, silk knitting. Study of different dyes, preparation of dyes, bleaching and dyeing of silk. Visit to cottage-weaving sectors.

Suggested readings

1. Anonymous, 2003, Seri-Business Manual, Vol. 3 Industrial sector, CSB.
2. Anonymous, 2013, Wild silks of India – A users compendium, Vol IV: Profiles of non-farm activities, CSB, Bengaluru, p.204.
3. Gohl, E.P.G. and Vilensky, L.D., 1999, Textile Science, An explanation of fibre properties. CBS Publishers and Distributors, Delhi, p.217.
4. Kanwar Varinder Pal Singh, 2004, Elementary idea of textile dyeing, printing and finishing. Kalyani Publishers, p.186.

Spun Silk Technology 1 (0+1)

Objectives

1. Usage of short or staple silk fibers to prepare a spun yarn
2. Utility of spun yarn

Practical

Spun Silk – Characters. Manufacturing of Spun silk. Systems of spun silk processing, Raw material for spinning mill or cottage spinnning by hand spinning tools. Silk wastes, pierced cocoons and Eri cocoons as raw material for spinning industry. Flow chart of spinning, spinning operations, procurement and storing of silk waste. Degumming, opening, Dressing, Drawing, Roving, Spinning, Gasing. Re-reeling and packaging of Spun silk. Hand spinning of cocoon wastes, Katia, Matka, Geecha silk. Equipments used in cottage spinning units - Takli, Natwa, Medleri charka, amber charaka, Das, Trivedi and Chowdary spinning wheels. Motorized cum pedal operated spinning wheel. Study of different types of silk wastes, different types of spun Silks-Katia, Matka, Geecha, Noil, Machine spun silk, Machines used in spun silk industry. Study of different silk wastes. Raw silk waste, opened waste, combed / Dressed waste, sliver, Rovings. Processing of silk waste / Eri cocoons / pierced cocoons. Visit to Silk testing and grading units / spun silk industry.

Apparels in Sericulture Industry 1 (0+1)

Objectives

1. This course aims at updating the knowledge of students in the various process right from fibre to fabric production.

This course focus on the following aspects viz. Silk Textile finishing, Silk fabric quality, Physical and chemical testing, Sourcing of raw materials, Textile designing, Sustainable practices.

Practical

Study of different types of yarns and fabrics and their classifications. Designs in fabrics, zaries blended fabrics. Caring of fabric, value addition in fabrics, Knitting, embroidery, embossing, dyeing, printing, self designing. Designing, Blending, Chiffon, Satin, Creping, Mercerisation. Induction of tentering, Special effects in fabric by different levels of twisting, combination of twisted yarns, blending of silk with other yarns. Designing of silk fabrics. Weaving- plain designs, zari designs. Loading/ weightening of silk/fabric. Silk in upholstery and interior decorations. Zari making from silk. Silk fabrics – traditional kacheevaram, dharmavaram, arni, illakal, molkalmur, pochampalli, venkatagiri, banarasi, rajasthani, paithani etc. apparels from vanya silks, Caring of silk fabrics.

Suggested readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation Volunteers, Japan, P.594.
2. Anonymous, 2000, Do's and Don'ts of Silk Twisting and Weaving Industry Part – II (Weaving), Central Silk Board, Bengaluru, P.35.
3. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P.376.
4. Bhattacharya, M. and Mahadevappa, D., 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, P.460.

5. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
6. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P.429.
7. Goswami, B.C., Martindale, J.G. and Scardino, F.L., 2010, Textile Yarns: Technology, Structure and Applications. Wiley India Edition, New Delhi, P.565.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P.215.
9. Mishra, S.P., 2006, A Textbook of Fibre Science and Technology, New Age International Publishers, New Delhi, P.326
10. Reddy, D.N.R., Shylaja, T.A. and Narayanaswamy, K.C., 2000, Reshmae Vasthra Vinyasa. CVG Publicaions, Bengaluru, P.78.
11. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P42.
12. Ullal, S.R. and Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. Central Silk Board, Bengaluru, P.209.

Journals

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian Silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/
- www.nift.ac.in/

Agricultural Marketing, Trade and Prices 2 (1+1)

Objectives

1. Agricultural marketing brings producers and consumers together through a series of activities and thus becomes an essential element of the economy and studying this helps the students to understand concept of agricultural marketing, trade and prices.
2. Explain the role of marketing in business and the importance of marketing in the business plan.

3. Assess the relative importance of marketing planning and to determine marketing strategies in relation to farming.
4. Identify target markets to select suitable marketing methods.
5. Explain the physical handling of products in the marketing process including packaging, labeling, presentation and transportation.
6. Plan to maintain sound customer relations in an agricultural business.
7. Conduct market research into a product or service in the agricultural industry.
8. Plan to manage the promotional program for an agricultural business.
9. Develop strategies to manage the marketing of an agricultural enterprise.

Theory

1. Agricultural marketing: Concepts and definitions of market. Marketing, Agricultural marketing.
2. Classification and characteristics of agricultural markets. Studying the problems of marketing. Market structure, Market mix and Market Segmentation.
3. Producer's surplus - marketable and marketed surplus. Factors affecting marketable surplus of agricultural commodities.
4. Product Life Cycle (PLC): Meaning, stages, characteristics. Competitive strategies: Strategies in different stages of PLC.
5. Market promotion-types, meaning, merits and demerits. Marketing process: Concentration, dispersion and equalization.
6. Marketing functions: Meaning and types- Exchange, Physical and Facilitating functions. Market functionaries: Types and importance of agencies involved in agricultural marketing.
7. Marketing channels: Meaning and definition. Marketing channels for different farm products.
8. Market Integration- Meaning and types.
9. Market efficiency, market cost, market margin and price spread - Meaning and definition. Factors affecting marketing cost, reasons for higher marketing cost and ways to reduce the cost. Market research- meaning and types.
10. Public sector institutions (CWC, SWC, FCI, CACP and DMI): Objectives and functions
11. Co-operative marketing in India: NAFED.
12. Trade: Concepts of International trade and its need. Present status and prospects.
13. Theories of International trade (Absolute and comparative advantage).
14. GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture,
15. Agricultural prices and policy: Meaning and functions. Need for agricultural price policy. Administered prices (MSP).

Practical

1. Study of relationship between market arrivals and prices of some selected commodities.
2. Computation of marketable and marketed surplus of important commodities.
3. Visit to local markets to study various marketing functions performed by different agencies,

identification of marketing channels for commodities, collection and analysis of data on marketing costs, margins and price spread.

4. Visit to market institutions-NAFED, SWC, CWC to study their organization and functioning.
5. Visit to market institutions- e-marketing, regulated market, co-operative marketing society, Export house etc. to study their organization and functioning.

Suggested readings

SN	Authors	Title of the Book
1.	S.S. Acharya and N.L. Agarwal	Agricultural Marketing in India
2.	S. Subba Reddy, P. Raghu Ram, T.V. Neelakanta Sastry and I. Bhavani Devi	Agricultural Economics.
3.	Dr. V. Banumathy and Dr. S. Ravichandran	Agricultural Marketing, Finance and Export-Import of Agricultural commodities
4.	M. L. Jhinghan	International Economics
5.	Mukesh Pandey and Deepali Tewari	Rural and Agricultural Marketing

Introduction to Agroforestry 2 (1+1)

Objectives

1. To understand the basic principles of Forestry and Agroforestry that combines the production of Agricultural food, livestock and forest product.
2. To provide information on different Agroforestry systems and cultivation practices in relation to sericulture prevalent in the region.

Theory

Introduction - Definition of forest and forestry, branches of forestry, history and education of forestry in India, objectives of Silviculture, forest classification and types, crown classification, Tending operations: weeding. cleaning, thinning and pruning, Forest mensuration. Social forestry and its branches. Agroforestry-Definitions, Importance, history, Criteria of selection of tree in Agroforestry, different Agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens. Cultivation practices of two important tree species of the region (Mulberry and Hebbevu) in relation to Sericulture.

Practical

Identification of Important Agrofrestry tree species and seedlings. Collection of seeds of different tree. Diameter and height measurements, volume estimation. Nursery layout, seed sowing of important Agroforestry species. Field visit to different Agroforestry systems.

Suggested readings

1. Bandyopadhyay, K., 1997, A textbook of Agroforestry with Applications, Vikas Publishing House Pvt Ltd, New Delhi.
2. Chundawat D.S. and Gautam S.K., 2016, Textbook of Agroforestry, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.

3. Khanna. L.S., 2017, Principles and Practices of Silviculture, Khanna Bandhu, Dehradun.
4. Sagwal S.S., 2020, Introduction to Forestry, Kalyani Publishers, Ludhiana.

Bio Formulation and Nanotechnology 2 (1+1)

Theory

1. Introduction to Bio Formulation and Nanotechnology
   - Overview of Bio Formulation and Nanotechnology
   - Historical development and current trends
   - Importance and applications in various fields
2. Basics of Nanotechnology
   - Introduction to Nanomaterials
   - Properties of Nanomaterials
   - Synthesis methods of Nanoparticles
   - Characterization techniques (TEM, SEM, AFM, etc.)
3. Nanostructures in Biology
   - Biomolecules and their interactions with nanoparticles
   - Cellular uptake mechanisms
   - Biological barriers and overcoming strategies
4. Bio Formulation Techniques
   - Formulation of Nanoparticles
   - Encapsulation

Practical

Basic concepts of Nanoscience and Nanotechnology: Introduction, definition and meaning of nanotechnology, classification of nanomaterials, scientific revolutions –time and length scale in structures. Size effects on structure and morphology of nanoparticles. Synthesis of nano materials: Physical, chemical and biological methods. Role in Social, economic, ethical and ecological spheres. Green nanotechnology.

Application of nanotechnology in Agriculture: Effects of seed priming and foliar application of nanomaterial on growth and productivity of crops. Uptake and translocation of nanoparticles. Quantification of enhanced nano-nutrient content in edible parts. *In vitro* and field efficacy of nanoparticles (pesticides) against plant pathogens. Bioassay of nano-formulations of insecticide. Bio-safety of nano-formulations on natural enemies. Study the fate and behaviour of nano fertilizers in soils. Application of nanotechnology in recycling of Agriculture waste. Safety, toxicity and adoption of nanoparticles in the soil and aquatic life. Nanosensors in agriculture-nutrient, water, soil.

Renewable Energy in Agriculture and Allied Sector 3 (2+1)

Objectives

1. To study the different renewable energy sources and its' conversion technologies

2. To acquire a practical knowledge on design, installation, maintenance of potential renewable energy sources of the country
3. To study the classification of energy sources-contribution of non-conventional energy sources in agriculture sector
4. To familiarization with biomass utilization for size-reduction, production of bio alcohol, bio diesel and bio-oil production and its application
5. To Familiarization with design, types, maintenance of biogas plants and gasifier
6. To study a solar energy, its collection, conversion methods and applications
7. To study a wind energy and its application.

Theory

Classification of energy sources, contribution of these sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application. Familiarization with production of biogas and producer gas and modifications of IC engines for usage. Production of bioalcohol, biodiesel and bio-oil production and their utilization as bioenergy resource. Introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater; application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system: solar lighting system, solar lantern, solar fencing and solar pumping system and their application, introduction of wind energy and their application.

Practical

1. Availability and uses of non-conventional energy in agriculture sector
2. Bio fuel production from biomass and its application
3. Constructional details of different biogas plants (Deena bandu and KVIC), gas production, design aspects and and maintenance
4. Study of different types of gasifiers, running of gasifiers and and production of producer gas
5. Study and and constructional details of different solar gadgets like solar dryer, grain dryers
6. Study of constructional details of solar cookers
7. Study of constructional details of solar water heating systems
8. Study of solar photovoltaic system and and observing various factors (light intensity, direction) influencing efficiency of the photo-voltaic systems
9. Study of solar water pumps, solar fencing
10. Visit to solar photovoltaic farm
11. Visit to biogas-based power generation farm

Suggested readings

1. Chakravarthy, A. and Amalendu Chakraverty, 1989, Biotechnology and Other Alternative Technologies for Unitization of Biomass-Agricultural wastes. Ist Edition, Oxford and IBH Publishers, New Delhi.
2. Oja, T.P and Micheal, A.M., Principles of Agricultural Engineering, Vol-1, Jain brothers, New Delhi

3. Rai, G.D. 2004, Non-conventional Energy Sources, Kanna Publishers, New Delhi
4. Rajput, R.K. 2012. Non-conventional Energy sources, S. Chand Publishers
5. Rathore, N.S., Mathur, A.N, and Kothari, S., Alternative sources of Energy, ICAR Publiation
6. Veeresh Kumargoud, Tulsidas T.N., Eshwarappa. H., 2007. Biogas Technology, regional biogas development and training centre, UAS, GKVK, Bengaluru.
7. http://www.fao.org/biomass briquetting

Fundamentals of Agricultural Economics 2 (2+0)

Objectives

1. Understanding Economic Principles: It provides a foundation in economic theories and principles that are applicable to agricultural activities, including sericulture.
2. Market Analysis: Students learn about market dynamics, demand and supply factors, price determination, and market structures relevant to silk production and trade.
3. Cost-Benefit Analysis: They can evaluate the costs involved in sericulture operations, such as mulberry cultivation and silk rearing, against the potential benefits in terms of silk yield and profitability.
4. Resource Allocation: Learning about resource allocation helps students optimize the use of land, labor, capital, and other inputs in sericulture enterprises to maximize productivity and efficiency.

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro- and macro-economics, positive and normative analysis. Nature of economic Theory: Rrationality assumption, concept of equilibrium, economic laws as generalization of human behaviour. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: Meaning, definition, characteristics of agriculture, importance and its role in economic development. Technical change and types, Agricultural planning and development in the country. Land reforms: Meaning of land tenure,land tenancy, land reform measures – abolition of intermediaries, tenancy reforms, fixation of ceiling on land holdings, consolidation of holdings, development of cooperative farming. Agricultural labour and farm mechanization. Demand: Meaning, law of demand, demand schedule and demand curve, determinants, utility Theory: Law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, elasticity of demand: Concept and measurement of price elasticity, income elasticity and cross elasticity. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Production: Process, creation of utility, factors of production, laws of returns and returns to scale. Market structure: Meaning and types of market, basic features of perfectly competitive and imperfect markets. Distribution Theory: Meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and programs on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification

of money, money supply, general price index, inflation and deflation. Banking: Role in modern economy, Agricultural and public finance: Meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. Tax: Meaning, direct and indirect taxes, agricultural taxation, VAT. Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning, NITI Ayoga.

Suggested Readings

1. Ahuja, H.L., Advanced Economic Theory: Microeconomic Theory. S. Chand and Co. Pvt. Ltd., New Delhi.
2. Dewett, K.K. *et al.,* Modern Economic Theory. S. Chand and Co. Pvt. Ltd., Delhi.
3. Lekhi, R.K. and Joginder Singh, Agricultural Economics. Kalyani Publishers, Delhi.
4. Mitra, J.K., Economics – An introduction to its basic principles (Micro and Macro Economics). The World Press Pvt. Ltd., Calcutta.
5. Ruddar Datt and K.P. Sundharam, Indian Economy. S. Chand and Co. Pvt. Ltd., Delhi.
6. Samuelson, P.A. and Nordhaus, Economics. Tata McGraw Hill Education, New York.
7. Subbareddy, S. *et al.,* Agricultural Economics. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Fundamentals of Plant Pathology 3 (2+1)

Objectives

1. To study the importance of plant disease epidemics and its economic impact on crops.
2. To study biotic (living), mesobiotic (viruses / viroids), and abiotic (non-living and environmental) causes of diseases / disorders.
3. To study the different types symptoms, cause and pathogens characteristics and and its reproduction
4. To study the epidemiology of diseases.
5. To develop methods of management of plant diseases.

Theory

Introduction, scope and objectives of plant pathology: Definition, derivation and different disciplines of plant pathology; General terms (glossary) commonly used in plant pathology; Scope and objectives; Importance of plant pathology in agriculture.

Importance of plant diseases: Plant disease epidemics that cause economic imbalance over the years; Historical and present examples of losses caused by plant diseases viz. Irish famine, Bengal famine, Coffee rust, discovery of Bordeaux mixture, wheat rust etc.

History and development of plant pathology: Important milestones, famous discoveries/ inventions and contributions of National and International Phytopathologists; Development of Plant pathology in India.

Definition and concept of plant diseases: Plant disease; Conditions necessary for disease development; Disease triangle, disease tetrahedron/ pyramid concepts; classification of diseases based causal organism / agent, symptoms, plant organs they affect and type of host plant affected and mode of spread and severity.

Causes of plant diseases and symptoms: Plant diseases caused by abiotic and biotic agents; diseases caused by Fungi, bacteria, nematodes, viruses, Phytoplasmas and phanerogamic parasites.

Diseases due to biotic agents: Symptoms and Signs; Hypoplasia, Hyperplasia, Hypertrophy and Necrotic symptoms caused by Fungi, Bacteria, Viruses, Nematodes, Phytoplasmas etc.,

General characteristics of plant pathogens: Classification of Prokaryotes according to Bergey's manual of Systemic Bacteriology, Classification of fungi, and Classification of viruses, mollicutes and nematodes.

Growth and reproduction of plant pathogens and replication of plant viruses: Types of growth, methods of measurement and kinetics of growth observed in pathogens; Reproduction types and reproductive structures in plant pathogens; Multiplication of plant viruses and phytoplasmas. Reproduction in bacteria and nematodes.

Liberation / dispersal of plant pathogens and survival of plant pathogens: Active and passive discharge of spores / inoculum; mechanism of liberation; Distribution-dissemination, and direct and indirect methods of transmission; Introduction of plant diseases into India and in other countries; Survival of plant pathogens.

Types of parasitism and variability in plant pathogens: Biotrophs, necrotrophs, pathotrophs, facultative saprophytes; Variability in microorganisms and its necessity for survival; Mechanisms of variability in fungi: bacteria, viruses and nematodes. Mechanisms: Mutation, Recombination, Heterokaryosis, Heteroploidy, Parasexualism; Transmission, Transformation, Transduction and Conjugation.

Pathogenicity: Phenomenon of host infection by fungi, bacteria, viruses and nematodes, penetration, colonization, role of enzymes toxins and growth regulators in disease development and their classification. Introduction to principles of plant disease and management.

Practical

Study of Laboratory Equipment and Microscope, Study of Symptoms and Diagnosis of Plant Diseases, Study of Disease Symptoms Caused by Virus, Viriods and Mollicutes, Collection and Preservation of Disease Specimen, Morphological Characters of Fungi, Bacteria, Virus, Viriods, Molicutes and Nematodes, Macroscopic and Microscopic Examination of Plant Pathogenic Fungi and Nematodes, Microscopic Examination of Bacterial Cells Through Stainng Technique, Preparation of Culture Media and Sterilization, Isolation and Purification Techniques for Fungi and Bacteria, Virus Purification and Extraction of Nematodes, Methods of Incoulation and Proving Koch's Postulates, Study of Fungal Spore Liberation, Measurement of Size and Shape of Pathogens by Micrometry and Camera Lucida, Production of Pectolytic Enzymes (Degradation Of Pectin), Cellulase Production Test (Degradation of Cellulose), Study of Life Cycle of Fungal Plant Pathogens, Field Visit to Acquaint Plant disease Symptoms.

Suggested Readings

1) Agrios, G.N., 2006, Plant Pathology, Fourth Edition, Academic Press, New York, 996pp.

2) Mehrotra, R.S. and Ashok Agarwal, 2003, Plant Pathology, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

3) Singh, R.S., 2002, Introduction to Principles of Plant Pathology, Fourth Edition, Oxford and IBH, Publishers Co. Pvt. Ltd., New Delhi.

4) Tripathi, D.P., 2014, Introductory Plant Pathology, Kalyani Publishers, 380 pp.

SEMESTER-VII

Leading to B.Sc. Sericulture (Hons.)

Elective subject*		Course	Credit Hours
Elective - I Host Plant Production Technology	SCI 411	Techniques in Host Plants Improvement	5 (2+3)
	SHP 411	Techniques in Host Plants Production	5 (2+3)
	SHP 412	Techniques in Host Plants Protection	5 (2+3)
	SHP 413	Value Addition to Host Plants By products	5 (2+3)
		Total	20
Elective - II Cocoon Crop Production Technology	SCI 412	Techniques in Silkworm Crop Improvement	5 (2+3)
	SCP 411	Techniques in Silkworm Cocoon Production	5 (2+3)
	SCP 412	Techniques in Silkworm Crop Protection	5 (2+3)
	SCP 413	Value Addition to Silkworm Rearing By products	5 (2+3)
		Total	20
Elective - III Silk Product Science Technology	SPS 411	Techniques in Raw Silk Production	5 (2+3)
	SPS 412	Techniques in Spun Silk Technology	5 (2+3)
	SPS 413	Techniques in Post Reeling Technology	5 (2+3)
	SPS 414	Value Addition of Silk Industry By-products	5 (2+3)
		Total	**20**

*The student will take anyone elective as per choice

Techniques in Host Plants Improvement 5 (2+3)

Objectives:

1. To know basic knowledge about different plant improvement methods
2. Breeding methods used in mulberry for increase leaf production

Theory

1. General introduction about plant breeding- Role of plant breeding, Challenges before plant breeder, Objectives of plant breeding
2. History of plant breeding and Mendalian genetics
3. Importance of Plant Genetic Resources Germplasm activities and their conservation methods
4. Importance of Self incompatibility and Male sterility in plants

5. Inheritance of Economic Traits - Classification of Traits-Qualitative and Quantitative traits and Features of quantitative traits
6. Hybridization in plants- Objectives of hybridization, Types of hybridization and Procedure for hybridization
7. Back cross method of breeding - Requirement for back crosses transfer of dominant gene and transfer of recessive gene, merits of back cross methods
8. Heterosis and Inbreeding depression - Features, classification and effects of heterosis breeding, Procedure to develop inbred lines and their evaluation
9. Mutation Breeding - Definition and history of mutation, Types of mutations, Characteristics effects of mutations, Physical mutagens and their characteristics and mode of action of physical mutagens, Chromosomal aberrations
10. Polyploidy breeding - Classification of polyploids, Characteristics of polyploidy
11. Promising triploids in India
12. Stress resistance breeding for both biotic and abiotic factors
13. Method of breeding for vegetative propagated crops
14. Mulberry Varietal multiplication and distribution system
15. Primary and Secondary host plants of Eri silkworm
16. Distribution, Taxonomy and Floral biology of primary host plants of Eri silkworm Castor - *Ricinus communis* Tapioca: *Manihot utilissima* and Kesseru: *Heteropanax fragrans*
17. Primary and Secondary host plants of Tropical and temperate tasar silkworm: Distribution, Taxonomy and Floral biology of Primary host plants Tropical tasar silkworms: *Terminalia arjuna, Terminalia temontosa* and *Shorea robusta* Description of habitat, leaf, fruit and seed
18. Distribution, Taxonomy and Floral biology of Primary host plants temeperate tasar silkworms: Quercus species
19. Morphology /morphophytes of the muga silkworm food plants

Practical

1. Study of floral structure of mulberry
2. Study of floral biology of mulberry
3. Practicing of staggered pruning in mulberry for inducing flowering
4. Asexual mode of reproduction in mulberry
5. Sporogenesis: Micro and Megasporogenesis in mulberry
6. Pollination and crossing techniques in mulberry
7. Collection of mulberry fruits, extraction of seeds and raising of seedlings
8. Study of different gene interaction methods - incomplete dominance, codominance, lethal gene action, epistasis, supplementary gene action, complementary gene action, duplicate gene action and additive gene action
9. Study of varietal characteristics of released mulberry varieties
10. Hybridization techniques in mulberry
11. Conservation of mulberry Germaplasm

12. Visit to Germplasm research station, CSGRC, Hosur

Suggested readings

1. Essentials of plant breeding - Pundansingh
2. FAO manual on sericulture
3. Mulberry Breeding - Amitabha Sarkar
4. Plant breeding - B D Singh
5. Principles of plant breeding - R W Allard
6. Tasar Culture: Principles and Practices - CSB Publication

Journals

- Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
- Indian silk, CSB, Bengaluru
- Journal of Sericultural Science of Japan, Japan
- Seridoc, CSRTI (CSB), Mysore
- Sericologia, ISC, Bengaluru
- Korean Journal of Sericulture, Korea
- Indian Journal of Sericulture, CSRTI (CSB), Mysore
- And other Periodicals, Journals, Reports, Brochures, etc.

Techniques in Host Plants Production 5 (2+3)

Objectives

1. To understand the production technology of different host plants of mulberry, tasar, eri and muga silkworms
2. To develop the technical skills in nursery techniques, propagation and cultivation techniques for quality leaf production of different host plants
3. Maximization of profit in host plants leaf production

Theory

Introduction, climatic requirements, sexual and asexual methods of propagation of different host plants of mulberry and Vanya silkworm. Popular varietal performance, improvement, varieties of mulberry and host plants of vanya silkworms recommended for different region of India. Nursery techniques, kissan nursery and its economics. Different pruning methods, irrigation schedules, integrated nutrient management system recommended for different host plants of mulberry (Both irrigated and rain fed mulberry) and Vanya sericulture. Weed management practices. Harvesting methods, leaf preservation techniques. Package of practices of tree mulberry plantation and chawki / young age mulberry plantation. Cultivation and propogation of host plants of eri silkworms: castor, tapioca and kesaru, cultivation and propogation of host plants of tropical tasar silkworms: Asan, Arjun and sal and temperate tasar / oak tasar silkworms: *Quercus serrata* and *Quercus incana*. Cultivation and propogation of host plants of muga silkworms - som and soalu. Economics of leaf production of mulberry and host plants of eri. muga and tasar silkworms.

Practical

Identification of host plants of mulberry silkworm, Eri silkworm, tasar silkworms and muga silkworms. Nursery bed preparation and raising of seedling through sexual propagation and saplings through asexual propagation in mulberry and and host plants of eri. muga and tasar silkworm.

Manures and fertilizer application. Planting methods. Irrigation, pruning methods, weed management. Harvesting and preservation of different host plants of silkworm. Cultivation of primary host plants of eri silkworms and tasar silkworms and cultivation of secondary host plants of muga silkworms. Herbarium preparation for the host plants and weeds.

Suggested readings

1. Anonymous, 2003, Sericulture Buisness manual – A user's guide. Vol. 1.
2. Anonymous, 2007, Tasar culture – Principles and Practices. Vol.1.
3. Choudhury P.C. and Giridhar, K., 1987, Mulberry cultivation. "Appropriate sericulture techniques", Manjeet S. Jolly (ed.). International Centre for Training and Research in Tropical Sericulture, Mysore, pp.18-34.
4. Ganga, G. and Sulochanachetty, J., Introduction to Sericulture.
5. Minamizawa K.,1997, Moriculture, Science of Mulberry Cultivation. Oxford and IBH Publishing Co. Pvt. Ltd. pp.235-285.
6. Rajanna L., Das P.K., Ravindran S., Bogesha K., Mishra R.K., Singhvi N.R., Katiyar R.S. and Jayaram H. 2005. Mulberry Cultivation and Physiology. CSB, pp.1-206.
7. Rajanna L., Das P.K., Ravidran S., Bhogesha K., Mishra R.K., Singhvi N.R., Katiyar R.S. and Jayaram H., 2005, Mulberry Cultivation and Physiology. CSB, p.206.
8. Rangaswami, G. and Manjeet S. Jolly, e-manual 1 - Mulberry Cultivation. FAO, Rome, p. 149.
9. Suryanarayana, N. (Chief ed.), Gangawar, S.K., Kumar R. and Srivastava A.K. (eds), Tasar silkworm host plants – Production, Protection and improvement. CTRTI, Piska Nagari, Ranchi. p.266

Techniques in Host Plant Protection 5 (2+3)

Objectives

1. Studying the pest and diseases of host plants of silkworms. Developing the technical skill regarding IPM practices for pest management.
2. Guiding the technical knowledge for effective management of pests and disease in host plants, by using innovative pest control method.

Theory

Concepts and principles of crop pest management, status of a pest. Biotic potential and environmental resistance. Insect and non-insect pests of Host plants of mulberry and non-mulberry silkworms (Host plants of tasar, eri and muga silkworms namely *Terminalia*s pp. Sal, Oak, Castor etc.) sequence of their appearance, duration, intensity, nature and symptoms of attack. Bioecology of pests, management practices, measures of control. Pesticides residue problems, safety periods to be observed. Economic importance, symptoms, causes, epidemiology, disease cycle/life cycle and integrated management of diseases of *Morus alba, Ricinus communis, Manihot utilisima, Michilius*

champaka, Zizypus spp., *Machilus bombycina, Shorea robhusta, Ailanthus* spp., and other hosts of silkworms. Principles and methods of plant disease management: Avoidance of the pathogen: Choice of geographical area, selection of field and planting stock. Exclusion: Plant quarantine regulations and inspections, Post entry quarantine. Eradication: Cultural and physical methods of eradication and inoculums reduction. Biological methods: Crops rotation, use of trap crops, plant and plant products, use of biological control agents, their mass multiplication mechanisms of bio-control. Breeding for disease resistance: Types of resistance, Development of resistant varieties, induced resistance. Protection chemical methods: Nature, classification, mode of action and formulations of fungicides, bactericides antibiotics and nematicides; methods of applications of chemicals. Application of biotechnology in plant disease management.

Practical

Study of various pests of host plants, their diagnostic characters, symptoms of damage and management measures to be adopted. Visit to crop fields to record the incidence of pests noticed and control measures, management practices suggested in each case, in addition to recording nature and symptoms of damage and estimation of loses. Collection of pests and affected samples of host plants of silkworms. Study of symptoms, etiology and life cycle/disease cycle of the diseases of *Morus alba, Ricinus communis, Manihot utilisima, Michilius champaka, Zizypus*s pp., *Quarcus* spp., *Machilus bombycina, Shorea robhusta, Ailanthus* spp., and other hosts of silkworms. Study of fungicides, bactericides, nematicides and methods of applications. Isolation, mass multiplication of Biocontrol agents and their bioassay. Study of plant protection equipments. (Submission of 15 well preserved disease specimens and 15 semi-permanent slides depicting different plant pathogens).

Suggested readings

1. Khan, M.A., Anil Dhar. And Zeya, S.B. 2014. Pests and Diseases of Mulberry and their Management, M/s Bishen Singh Mahendra Pal Singh.
2. Sathe, T.V. and Jadhav, A. 2002. Sericulture and Pest Management, Daya Publishing House.
3. Nalliappan, Sakthivel, Mulberry pests: current status and management practices, 2019. Central Sericultural Research and Training Institute, Central Silk Board.
4. R.N. Singh and Beera Saratchandra. 2001. Sericulture Entomology.
5. R.N. Singh, M.V. Samson, R.K. Datta. 2000. Pest management in Sericulture. Indian Publisher and Distributions, Delhi.
6. Sathejadhar, 2012, Sericulture and Pest management.
7. Mohammad Ashraf Khan, Madan Mohan Bhat and Tribhuwan Singh. 2011. Silkworm Crop Protection, Daya Publishing House, Delhi.
8. Subrata Biswas and and N.P. Singh. 2005. Parasitic Diseases of Mulberry. Kalyani Publishers.

Value Addition to Host Plants By-Products 5 (2+3)

Objectives

1. To make the students understand value addition to by-products of major host plants of silkworms (Mulberry, tasar, eri and muga), its utilization and entrepreneurship development thus making sericulture as one of the most profitable agro-enterprises.

2. To understand the best utilization of by-products generated during host plant production process and their value addition for generating additional income making them good entrepreneurial managers in sericulture by exploring the entrepreneurial opportunities to make sericulture as one of the profitable enterprises for sustainable sericulture.

Theory

Value addition to mulberry leaf - Importance, animal feed mulberry leaf anti-oxidation and Anti-aging, mulberry leaf extract in pharmaceuticals, cosmetics production, skin and hair caring products, hair dressing products, mulberry leaf soap. Mulberry tea: Health benefits of mulberry tea. Mulberry fruit: multipurpose uses of mulberry fruit, mulberry fruit jam, mulberry fruit syrup, mulberry fruit juice. Mulberry stem: Adhesive from waste mulberry stem, mulberry as fodder and fuel, mulberry wood art, mulberry root art, utilization of mulberry twigs for basket making.

Uses of arjun (*Terminalia arjuna*): Medicinal uses of arjun leaf, bark ashes and fruit. Uses of asan (*Terminalia tomentosa*) wood as furniture, decorative veneers and for musical instruments. Extraction of dye *and* tan leather from bark.

Uses of sal (*Shorea robusta*): Important sources of hardwood *timber in India, properties and uses of wood, dry leaves, sal tree resin. Sal seeds and fruit as a source of lamp oil and vegetable fat and cooking oil. Castor leaf for medicinal uses, castor oil produced from castor beans: important commercial value manufacturing of soaps, lubricants and coatings, castor bean cake for manure production. Cassava root and leaves for edible purpose. The nutritional value of cassava. Kesseru (Heteropanax fragrans*): rich source of manure, medicinal benefits.

Host plants of muga silkworm, *Litsea polyantha*: Medicinal uses of plant bark and leaves, source of fodder for the livestock, planted as ornamental plant. *Machilus bombycina*: Medicinal uses of plant bark and leaves, plant essential oil and its application.

Practical

Importance and scope of by-product utilization from major host plants of silkworms, Value addition during host plant cultivation: kisan nursery, composting, vermicomposting, livestock production. Medicinal uses of different parts of host plants and applications.

Suggested readings

1. Dandin, S.B., Jayant, Jayaswal and Giridhar, K. (Eds.)., 2003, Handbook of Sericulture Technologies. CSB, Bengaluru.
2. Govindan, R., Chinnaswamy, K.P., Krishnaprasad, N.K. and Reddy, D.N.R., 2000, Non-Mulberry Sericulture, Silk Technology and Sericulture Economics and Extension. Vol. 3 – Proceedings of NSTS – 1999, UAS, Bengaluru.
3. Sanjay Sinha., 1990, The Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.

Techniques in Silkworm Crop Improvement **5 (2+3)**

Objectives

1. Studying the genetics background of mulberry and non-mulberry silkworm. Developing the technical skill regarding handling the parental race maintenance, hybridization, multiplication and addressing the stress tolerance research gap.

2. Guiding the technical knowledge to make of available silkworm germplasm for hybridization. To Study the concept of conventional and non-conventional silkworm breeding methodology to develop robust silkworm hybrids.

Theory

Principles and objectives of breeding in mulberry and non-mulberry silkworm. Establishing / activities of silkworm breeding program. Maintenance of silkworm germplasm bank. Maintenance of breeds / stocks, 3-tier multiplication of parental stock with silk yield attributes. Genetic basis for silkworm breeding programs. Hybridization - objectives, types, hybridization procedure, problems in hybridization like inbreeding depression, lethal genes, etc. Heterosis studies in mulberry and non-mulberry silkworm, genetic basis for heterosis, manifestation of heterosis, commercial exploitation of heterosis, Parthenogenesis – methods of induction of parthenogenesis. Mutation Breeding – Mutagens - classification of mutagens, Procedure for mutation breeding. Ploidy breeding – heteroploid, autopolyploids, significance of polyploids. Breeding silkworms for biotic (disease) and abiotic (high temperature) stress tolerance, season and region specific mulberry and non-mulberry silkworm hybrids. Concepts of breeding auto-sexing silkworm breeds. Authorization of silkworm breeds and their hybrids. Breeding of non-mulberry silkworms.

Practical

Study of breed characteristics of *Bombyx mori*, Antheraea sp., and *Samia ricini*. Procedure and maintenance of silkworm germplasm bank. Procedure for hybridization in silkworms, Procedure for selection- pedigree and mass method. Assessment of variability (ANOVA). Genetic analysis of qualitative and quantitative traits. Estimation of heterosis. Diallel (partial and complete) and three-way cross analysis. Analysis of double cross hybrids. Line × Tester analysis. Path analysis.

Suggested readings

1. Gardner E J, Simmous M J and Snustad D P (1991). Principles of Genetics. John Willey and Sons Inc., New York. P. 649.
2. Sarkar D D (1998). The Silkworm Biology, Genetics and Breeding. Vikas Publishing House Pvt. Ltd., New Delhi. P. 338.
3. Sarkar Dilip De (1998). The Silkworm - Biology, Genetics and Breeding. Vikas Publishing House Pvt. Ltd., New Delhi.
4. and Basavaraj, H K Ashwath, S K, Kumar, N Suresh, Mal Reddy N and Kalpana G V (2005). Silkworm Breeding and Genetics, Central Silk Board, Bengaluru.
5. Sreerama Reddy G (ed.) (1998). Sikworm Breeding. Oxford and IBH Publishing Co Pvt. Ltd., New Delhi and Calcatta.
6. Tazima Y (1978). The Silkworm: An important Laboratory Tool. Kodansha Ltd., Tokyo, Japan. P. 307.

Techniques in Silkworm Cocoon Production 5 (2+3)

Objectives

1. Students needs to acquire the knowledge and skills, required for successful silkworm cocoon crop production.

2. To impart the knowledge of silkworm rearing to students.
3. To plan and execute silkworm rearing for both commercial and seed cocoon production

Theory

Garden management for quality host plants production (Mulberry and Non-mulberry); INM in mulberry and non-mulberry, harvesting index, harvesting and preservation of leaves; Planning for silkworm rearing suitable to different sized host plant garden holdings, rearing house, equipment and labour availability; Disinfection of rearing house and appliances, hygiene measures in rearing house; Procurement of quality DFLs, Improved method of incubation, black boxing, Calculation of hatching percentage, brushing; Different methods of Chawki and late-age silkworm rearing; Management of rearing environment; Silkworm feed, spacing, bed and moulting managements; Disease and Pest Management; Mounting of ripe worms and maintenance of environment in mountage shed; Harvesting, sorting, grading and marketing of cocoons; Feed utilization and conversion efficiency; Nutritional requirement of silkworms, *vis-a-vis* their availability in leaves / feed; Different nutrients and their role in silkworm growth, development and silk production; Nutrient supplements through mulberry leaf fortification; Application of artificial diets and juvenile hormone analogues in practical sericulture; Innovations and indigenous technology know how; Maintenance of rearing records; Economics of silkworm rearing; Project preparation and Benefit cost ratio of silkworm rearing.

Practical

Raising garden for quality host plants production; Disinfection of rearing houses; Large scale chawki rearing with available facilities; Large scale late-age silkworm rearing with available facilities; Practicing the management of rearing environment; Silkworms feed, spacing, bed and Moulting management; Management of diseases and natural enemies; Practicing mounting of ripe worms and maintenance of environment in mountage shed; Practicing harvesting, sorting, grading and marketing of cocoons; Practicing of application of artificial diets and juvenile hormone analogues during silkworm rearing; Practicing of maintenance of rearing records; Working out the economics of silkworm rearing; Preparing the Silkworm rearing project; Visit to Seri-agro-ecosystems (farmer's field); Visit to R and D institute;

Suggested readings

Textbooks

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation Volunteers, Japan, P.594.
2. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P.376.
3. Dandin, S.B. and Giridhar, 2010, Handbook of Sericulture Technologies. CSB, Bengaluru, P.427.
4. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
5. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P.429.
6. Govindaiah, Gupta, V.P, Sharma, D.D., Rajadurai, S. and Nishitha Naik, V., 2005, Textbook on Mulberry Crop Protection. Central Silk Board, Bengaluru, P. 247.

7. Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Principles of Silkworm Pathology. Seri Scientific Publishers, P.420.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P.215.
9. Krishnaswami, S., Narasimhanna, M.N., Suryanarayan, S.K. and Kumararaj, S., 1979, Silkworm Rearing. FAO Manual, Vol. II, FAO, Rome, pp.99-129.
10. Narayanaswamy, K.C. and Devaiah, M.C., 1998, Silkworm Uzi Fly. Zen Publishers, Bengaluru, P.232.
11. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection. Central Silk Board, Bengaluru, pp.1 – 324.
12. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P42.
13. Ullal, S.R. and Narasimhanna, M.N. 1981, Handbook of Practical Sericulture, Central Silk Board, Bengaluru, P.209.

Journals

1. Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
2. Indian Silk, CSB, Bengaluru
3. Journal of Sericultural Science of Japan, Japan
4. Seridoc, CSRTI (CSB), Mysore
5. Sericologia, ISC, Bengaluru
6. Korean Journal of Sericulture, Korea
7. Indian Journal of Sericulture, CSRTI (CSB), Mysore
8. And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/

Techniques in Silkworm Crop Protection 5 (2+3)

Objectives

1. Students needs to acquire the knowledge and skills required for the management of silkworm pests and diseases.
2. To familiarize students about the silkworm pests and diseases.
3. To manage biotic and abiotic factors according to season.
4. To assess the cocoon crop loss due to biotic and abiotic factors.
5. To mitigate the probable unforeseen risks during silkworm crop period.

Theory

Serology and its application in silkworm pathology; Isolation, ultra-purification and long-term storage of silkworm pathogens; Infectivity techniques in silkworm pathology; Cross infectivity of pathogens of crop pests to silkworms; Impact of insect crop pests on silkworm; Impact of biological pest control on sericulture; Pest management concepts; Assessment of toxicity, their nature, level and suggest remedies; Development of IPM and IDM schedules for management of pest and and diseases; Diagnosis of pest and disease incidence in silkworm rearing and acquainting with remedial measures; Survey of problematic rearing houses and find out the remedies for the cause.

Practical

Practicing the various serological techniques used in silkworm pathology; Isolation and purification of viruses and dissolution of viral inclusion bodies; Practicing the various infectivity techniques applicable in silkworm pathology; Studying the effects of cross infectivity in sericulture; Determination of LC_{50} and ET_{50}; Determination of silkworm breed and instar susceptibility; Practicing various histo-pathological techniques employed in the silkworm pathology; Studies on patho-physiological alterations due to silkworm pathogens; Development of IPM and IDM schedules for management of pest and diseases; Diagnosis of pest and disease incidence in silkworm rearing and acquainting with remedial measures; Survey of problematic rearing houses and find out the remedies; Case studies.

Suggested readings

1. Anonymous, 1975, Textbook of Tropical Sericulture. Japan Overseas Co-operation Volunteers, Japan, P.594.
2. Aruga, H., 1994, Principles of Sericulture. Oxford and IBH, New Delhi, P.376.
3. Dandin, S.B. and Giridhar, 2010, Handbook of Sericulture Technologies. CSB, Bengaluru, P.427.
4. Ganga, G. and Sulochana Chetty, J., 1991, An Introduction to Sericulture. Oxford and IBH, New Delhi, P.176.
5. Ganga, G., 2003, Comprehensive Sericulture. Volume 2, Silkworm Rearing and Silk Reeling. Oxford and IBH, New Delhi, P.429.
6. Govindaiah, Gupta, V.P, Sharma, D.D., Rajadurai, S. and Nishitha Naik, V., 2005, Textbook on Mulberry Crop Protection. Central Silk Board, Bengaluru, P.247.
7. Govindan, R., Narayanaswamy, T.K. and Devaiah, M.C., 1998, Principles of Silkworm Pathology. Seri Scientific Publishers, P.420.
8. Jolly, M.S., 1987, Appropriate Sericulture Techniques. Central Sericultural Research and Training Institute, CSB, Mysore, P.215.
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11. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C., 2005, Silkworm Crop Protection. Central Silk Board, Bengaluru, pp.1 – 324.

12. Sengupta, K., 1989, A Guide for Bivoltine Sericulture. Central Sericultural Research and Training Institute, Mysore, P.42.
13. Ullal, S.R. and Narasimhanna, M.N. 1981, Handbook of Practical Sericulture, Central Silk Board, Bengaluru, P.209.

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1. Bulletin of Indian Academy of Sericulture, CSTRI, Berhampore
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3. Journal of Sericultural Science of Japan, Japan
4. Seridoc, CSRTI (CSB), Mysore
5. Sericologia, ISC, Bengaluru
6. Korean Journal of Sericulture, Korea
7. Indian Journal of Sericulture, CSRTI (CSB), Mysore
8. And other Periodicals, Journals, Reports, Brochures, etc.

Online Sources:

- www.csb.gov.in/
- www.karnataka.gov.in/kssrdi/
- www.tnau.ac.in/
- www.csrtimys.res.in/

Value Addition to Silkworm Rearing By-Products **5 (2+3)**

Objectives

1. To make students understand all seri-by-products and its utilization and also entrepreneurship development thus making sericulture as one of the most profitable agro-enterprises.
2. To understand the best utilization of by-products generated at each stage of Silkworm rearing and their value addition for generating additional income making them good entrepreneurial managers in sericulture by exploring the vast entrepreneurial opportunities to make sericulture as one of the profitable enterprises for sustainable sericulture.

Theory

1. Introduction: scope and importance of by-product utilization during silkworm rearing
2. Utilization of mulberry silkworm, *Bombyx mori* L, bed waste for effective recycling as nutri-rich manure- Compost, vermicompost, biodigester
3. Utilization of non-mulberry silkworms (Eri, Tasar and Muga) fecal matter for effective recycling as manure
4. Scope and importance of Biogas and production of biogas by using silkworms fecal matter
5. Importance of chlorophyll extraction from silkworms fecal matter and its applications
6. Scope and importance of mushroom production by using silkwroms rearing waste
7. Scope and importance of production of *Cordyceps mylitaris*, utilization of silkworm larvae for production of *Cordyceps mylitaris* and health benefits.

Practical

Importance and scope of bi-product utilization in silkworm rearing, Value addition during silkworm rearing: composting, vermin-composting, bio-digester, biogas production, livestock production, pisciculture, mushroom cultivation, silkworm litter as livestock feed; as an organic manure, poultry feed, silkworm excreta: chlorophyll extraction and its applications

Suggested readings

- Anonymous, 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Bernard, P. Corbman., 1983, Textiles: Fiber to Fabric. 6th Edition. Mc. Graw – Hill

International Editions, Home Economic Series, Singapore, p. 594.

- Dandin, S.B. and Gupta, V.P., 2002, Advances in Indian Sericulture Research. CSR&TI, Mysore.
- Dandin, S.B., Jayant, Jayaswal. and Giridhar, K. (eds.)., 2003, Handbook of Sericulture Technologies. CSB, Bengaluru.
- Govindan, R., Chinnaswamy, K.P., Krishnaprasad, N.K. and Reddy, D.N.R., 2000, Non-Mulberry Sericulture, Silk Technology and Sericulture Economics and Extension. Vol. 3– Proceedings of NSTS – 1999, UAS, Bengaluru.
- Sanjay, Sinha, 1990, The Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Ullal, S.R. and Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. CSB, Bengaluru.

Techniques in Raw Silk Production 5 (2+3)

Objectives

1. To understand the processing of cocoon for reeling a silk yarn
2. To acquaint with the skills of cocoon reeling and raw silk production

Theory

World raw silk production and present silk production in India, Cocoon formation, Physical characteristics of mulberry cocoon- colour, shape, wrinkles etc., Cocoon markets-their functions, method of transaction, method of fixing the cocoon price, Transportation of cocoons-care and handling, Cocoon testing and grading, Cocoon sorting-manual and mechanical method. Different types of defective cocoons, Mulberry silk reeling process-steps involved in silk reeling, Cocoon stifling and methods, storage of stifled cocoons-sun drying, steam stifling, hot air drying, Cocoon cooking and its systems, open pan, two pan, three pan, pressurized cooking method/central cocoon boiling machine, mechanical cooking, brushing methods, Evolution of reeling machines. General principles in reeling, different reeling machines-charakha, improved charakha, cottage basin/domestic basin, multiend reeling machine, semi automatic and automatic reeling machine. Re-reeling and lacing, Silk examination, skeining, book and bale making, Storage and selling raw silk, silk exchange,

Practical

Physical and commercial properties of cocoons, sorting of cocoons, types of reelable and unreelable defective cocoons, cocoon stifling by steam method, hot air stifling by chamber method

and storage of cocoons, cocoon cooking – open pan method, two pan and three pan method, hands on traininng in cocoon reeling for raw silk production in cottage basin and multiand end reeling machine, lacing, silk examination and skein submission. Crossbreed / Bivoltine silk reeling. Visit to silk exchange, filature and automatic reeling machine units.

Suggested readings

1. Anonymous, 2003, Seri business manual. CSB, Bengaluru.
2. Anonymous, 2003, Vanya silks. CSB, Bengaluru.
3. Krishnaswami, S., Madhava Rao, N.R., Suryanarayan, S.K. and Sundaramurthy, T.S., 1972, Sericulture Manual 3- silk reeling. FAO, Rome. p.112.
4. Mahadevappa, V.G. Haliyal, D.G. Shankar and Ravindra Bhandiwad, Mulberry silk reeling technology by Yong-woo Lee, Silk reeling and testing manual. National Sericulture and Entomology Institute, Seoul, Republic of Korea.
5. Tammanna N. Sonuwalker, Handbook of silk technology.

Techniques in Spun Silk Technology 5 (2+3)

Objectives

1. Using eri cocoon and short staple silk fibers from mulberry and tasar to prepare spun like yarn
2. Utility of spun like yarn.

Theory

Different raw materials for spun silk production, availability and its utility in fabric manufacturing. Eri cocoon cooking, preparation of cake, spinning with hand tools such as takli, natwa, pedal spinning machine, spinning wheel, simple charaka, amber charaka. Mechanical spinning in spun mills. Hand spinning of cocoon wastes – mulberry cocoon, tasar cocoon and muga cocoons by thigh spinning, matka spinning. Utility of silk wastes such as cookers waste, reelers waste, rereeling, winding, twisting, doubling and weaving wastes of mulberry and tasar. Noil silk - waste produced in spun silk mills. Properties of spun silk yarn and its comparison with raw silk. Processing of spun silk yarn for fabric production. Dyeing, preparation of warp yarn, weft yarn with different counts. Quality assessment of spun silk and grading. Recycling of old / used silk fabric in spun silk production.

Practicals

Spun Silk – Characters. Manufacturing of spun silk. Systems of spun silk processing, Raw material for spinning mill or cottage spinnning by hand spinning tools. Silk wastes, pierced cocoons and Eri cocoons as raw material for spinning industry. Flow chart of spinning, spinning operations, procurement and storing of silk waste. Degumming, opening, Dressing, Drawing, Roving, Spinning, Gasing. Re-reeling and packaging of Spun silk. Hand spinning of cocoon wastes, Katia, Matka, Geecha silk. Equipments used in cottage spinning units - Takli, Natwa, Medleri charka, amber charaka, Das, Trivedi and Chowdary spinning wheels. Motorized cum pedal operated spinning wheel. Study of different types of silk wastes, different types of spun silks-Katia, Matka, Geecha, Noil, Machine spun silk, Machines used in spun silk industry. Study of different silk wastes. Raw silk waste, opened waste, combed / Dressed waste, sliver, Rovings. Processing of silk waste / Eri cocoons / pierced cocoons. Visit to Silk testing and grading units / spun silk industry.

Techniques in Post Reeling Technology **5 (2+3)**

Objectives

1. To make students confident in producing issue fabric from raw silk
2. To understand the processing of raw silk yarn for weaving a fabric
3. To acqaint with the skills of raw silk processing for fabric production

Theory

Twisting of raw silk (Throwster's unit) - Soaking of raw silk, winding, doubling – making different plys of silk yarn, mixing up of the yarns and twisting. Different types of twist – S twist, Z twist and production of different types of yarns. Steaming and Re-reeling. Maintenance of working condition of throwsters unit. Working out tho economics of cost of production of twisted yarn. Wet processing of twisted silk yarn - Degumming – methodology, Dyeing of yarn – different types of dyes, methods of dyeing and its application for silk dyeing. Warp making – different methods of warping – ball warping, drum warping. Weft yarn prepartion. Working out the economics of silk warping. Visit to throwsters unit and warp making units. Wet processing – at yarn stage and at fabric stage. Degumming (boil off) of silk – soupling, Ecru silk. Bleaching of silk, methods, Dyeing of silk – dyeing of silk with acid dyes, metal complex dyes, reactive dyes, vinyl sulphone dyes, direct dyes. After treatment of dyeing. Washing, acid treatment, hydro extractor, drying, skeining and packing. Silk printing for fabric. Classification of printing styles-silk printing styles. Printing tools and devices and quality control in printing. Silk finishing-mechanical: dry and wet, chemical finishing. Application of the finish. Finishes for the functional products. Weaving – handloom and powerloom weaving. Handloom weaving types - frame loom and pit loom, drawing – in and denting, heald shaft, heald count, reed, reed count, systems of counting, gaiting and piercing, yarn arrangement over the heald frames – straight, pointed and skip draft. Basic mechanisms of interlacing – primary, secondary and auxillary motions. Shedding – different types of shedding mechanisms-dobby, tappet (treadles) and jacquard. Types of shed. Picking mechanisms, beat up mechanism, warp let off and take up motions. Warp stop motion and filling stop motion, warp protector motion, transverse fabric control. Selvedges. Fabric structure- weave, thread densities of warp and weft, the coarseness and fineness of warp and weft yarn, the waviness of warp and weft, Basic fabric properties. Woven fabric Design-Plain weave, ornamentation of plain cloth, warp rib weave, weft rib weave and Basket (matte weave) - 2 × 2, 3 × 3 or 4 × 4. Twill weave – 2/1 or ½, 2/2 3/3 4/4. Satin and sateen weaves. Concept of fabric quality, perspectives of fabric quality and fabric defects. Importance of crimps, Silk sarees of different weaving clusters, crepe fabrics, georgette, chiffon, soft silk fabrics, organza, tafetta, habutai and tabby. Power loom shuttle and shuttle less looms (gripper and jet-picking mechanism).

Practical

Silk throwing-winding, doubling, twisting-types of twisting. Steam setting of twisted yarn. Warping and yarn winding. Degumming of silk; Methods of degumming, water quality for wet processing. Bleaching and dyeing, classification of dyes, factors influencing dyeing, preparation of dye and methods of dyeing. Study of different types of looms and their characteristics. Printing and methods of printing –block and screen printing. Weaving-loom and its structure, different types of looms, arrangement of yarn for simple weaving and design weaving. Textile Designing, Motifs for weaving and textile printing, silk / fabric finishing, silk knitting. Study of different dyes, preparation of dyes, bleaching and dyeing of silk. Visit to cottage-weaving sectors.

Suggested readings

1. Anonymous, 2003, Seri-Business Manual, Vol. 3 Industrial sector. CSB.
2. Kanwar Varinder Pal Singh, 2004, Elementary idea of textile dyeing, printing and finishing. Kalyani Publishers, p.186.

Value Addition in Silk Industry By-Product 5(2+3)

Objectives

1. To make the students understand all silk industry by-products and its utilization and entrepreneurship development, thus making sericulture as one of the most profitable agro-enterprises.
2. To understand the best utilization of by-products generated at each stage of post cocoon processing and their value addition for generating additional income making them good entrepreneurial managers in sericulture by exploring the entrepreneurial opportunities to make sericulture as one of the profitable enterprises for sustainable sericulture.

Theory

1. Introduction: scope and importance of by-product utilization in silk industry
2. Silk reeling byproducts: utilization, processing and applications of silk reeling water, pelade layer, silk waste and pupa
3. Silkworm pupa as best source of protien for poultry and fish feed and its importance as human food
4. Silkworm pupal oil extraction, pupal cake and its applications
5. Scope and Importance of biodigeter: use of silk reeling water for bidigester and its utilization as rich source of nutrients for mulberry and agricultural crops
6. Pharmaceutical importance of sericin and fibroin and its application, use of sericin and fiboin powder in cosmetics industry
7. Utilization of silk waste from reeling, re-reling, twisting, winding, doubling and weaving process as spun silk and its applications in furnishing material etc.
8. Non woven products using silk waste
9. Scope and imporance of cocoon crafts using pierced/cut cocoons: preparation of different cocoon crafts, economics and marketing of cocoon craft products

Practical

Importance and scope of by-product utilization in silk industry, Value addition during silk reeling: silk waste, reeling water, pupa, pelade layer. Re-reeling, winding, doubling and twisting waste composting, vermicomposting, bio-digester, bio gas production, livestock production, pisciculture, mushroom cultivation. Pupal oil extraction and its uses, pupal powder as animal feed and manure. Flimsy cocoons and waste cocoons for spun silk production and quilting purpose. Silkworm pupa in human consumption-commercialized products and locally prepared dishes. Preparation of handicrafts, toys, wall plates, garlands, greeting cards, etc., from pierced/ cut cocoons. Sericin for medicine, cosmetics, artificial membranes and plastic industry and other uses of silk.

Suggested readings

1. Anonymous., 2002, Silk Weaving. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
2. Bernard, P. Corbman., 1983, Textiles: Fiber to Fabric. 6th Edition. Mc. Graw – Hill International Editions, Home Economic Series, Singapore, p. 594.
3. Dandin, S.B. and Gupta, V.P., 2002, Advances in Indian Sericulture Research. CSR&TI, Mysore.
4. Dandin, S.B., Jayant, Jayaswal. and Giridhar, K. (eds.)., 2003, Handbook of Sericulture Technologies. CSB, Bengaluru.
5. Govindan, R., Chinnaswamy, K.P., Krishnaprasad, N.K. and Reddy, D.N.R., 2000, Non-Mulberry Sericulture, Silk Technology and Sericulture Economics and Extension. Vol. 3 – Proceedings of NSTS – 1999, UAS, Bengaluru.
6. Sanjay, Sinha., 1990, The Development of Indian Silk. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
7. Ullal, S.R. And Narasimhanna, M.N., 1981, Handbook of Practical Sericulture. CSB, Bengaluru.

SEMESTER-VIII

Leading to B.Sc. Sericulture (Hons.)

S. No.	Course Title	Credit Hours
1.	I. Student READY Program (RAWE/In-plant training/Industrial Attachment/ Experiential Learning/Hands on Training/Project Work)	20 (0+20)
	TOTAL	20 (0+20)

*Project can be R and D based, field study based or entrepreneurship based (incubation/ experiential learning) based.

Diksharabh: At the start of 1st Semester, there will be a two weeks Foundation Course (FC) with 0+2 credits (Non-gradial), common to all the students

* Educational (Study) Tour: It will be compulsory non-gradial of 2 credit for 10-12 days during/ after 5th semester

ELECTIVE COURSES

S. No.	Course Title	Credit Hours
1.	Techniques in Host Plants Production	5 (2+3)
2.	Techniques in Host Plants Protection	5 (2+3)
3.	Value Addition to Host Plants By products	5 (2+3)
4.	Techniques in Host Plants Improvement	5 (2+3)
5.	Techniques in Silkworm Crop Improvement	5 (2+3)
6.	Techniques in Silkworm Cocoon Production	5 (2+3)
7.	Techniques in Silkworm Crop Protection	5 (2+3)
8.	Value Addition to Silkworm Rearing By products	5 (2+3)
9.	Techniques in Raw Silk Production	5 (2+3)
10.	Techniques in Spun Silk Technology	5 (2+3)
11.	Techniques in Post Reeling Technology	5 (2+3)
12.	Value Addition of Silk Industry By-products	5 (2+3)

SKILL ENHANCEMENT COURSES (SEC)

Sl. No	SEC	Course Title	Credit Hours
1.	**SEC-I**	Mulberry Leaf Production Technology	4 (0+4)
2.		Silkworm Egg Production Technology	4 (0+4)
3.	**SEC-II**	Silkworm Rearing Technology	4 (0+4)
4.		Silk Reeling Technology	4 (0+4)
5.	**SEC-III**	Raw Silk Processing	2 (0+2)
6.		Weaving Technology	2 (0+2)
7.		Seri Clinic	2 (0+2)
8.	**SEC-IV**	Value Addition in Sericulture	2 (0+2)
9.		Entrepreneurship and Business Development in Sericulture	2 (0+2)

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses, (as per UGC guidelines for online courses) as a partial requirement for the B. Sc.(Hons.) Sericulture program.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

AGRIBUSINESS MANAGEMENT

Course Curricula for Undergraduate Program in Agribusiness Management UG - Certificate in Agribusiness Management UG - Diploma in Agribusiness Management B. Sc. (Hons.) Agribusiness Management

INTRODUCTION

As per the Terms of Reference of the 6th Deans" Committee, each member was assigned the task of restructuring the Undergraduate Program s in different disciplines. This report is an outcome of the valuable suggestions and recommendations of the Sixth Deans" Committee after having multistage in-depth deliberations and discussions in virtual meetings in addition to personal communications with the selected faculty members of the Agribusiness Management discipline of various State Agricultural Universities, ICAR Institutes and Private Agricultural Colleges, stakeholders from related industries and few alumni of the existing course Program across nation.

Restructuring of Undergraduate Program s in Agribusiness Management has been carried out as per National Education Policy (NEP) guidelines to build among students a strong foundation of knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge.

In the present restructured course curriculum, more emphasis has been given to basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses via electives and online courses along with provision of advanced skill development through project work or experiential learning, etc. In addition, the provision of multiple exit and entry options at every stage in the educational career of students, which is a unique feature of the NEP, has been incorporated in the restructured course curriculum of Agribusiness Management degree program .

The details of the course structure for the Undergraduate Program s in Agribusiness Management [UG-Certificate, UG-Diploma and B.Sc. (Hons.) Agribusiness Management] have been prepared with due care and with inputs of Deans' and faculty members in the field of Agribusiness Management, across the country.

HIGHLIGHTS

- The 4-year undergraduate degree program in Agribusiness Management will consist of 167 credits and 4 credits of non-gradial courses will be additional. In addition, 10 credits of online courses have to be taken by the student as per his/her/ze choice with the consent of the Dean of the concerned College.
- More weightage has been given to skill enhancement courses in first two years. Students have been given flexibility and choice in selection of skill enhancement courses from a basket of multiple skill enhancement courses offered in all the four semesters of first two years.
- Students will be given 12 credits of skill-based courses in first, second, third and fourth semesters so that he/she will acquire enough knowledge and skill through hands-on training in related domain to get Certificate at the end of first year and Diploma at the end of second year, if he/she opts to exit.
- After completing the courses of first year, if a student wishes to exit, he/she will be eligible for award of UG-Certificate in Agribusiness Management after completing an extra 10 weeks of internship (10 credits). The internship can be taken in the form of Industry placement/ Industry exposure/ Hands on training in related domain in the parent institute. The students continuing the study further would not have to attend the internship after first year. Similarly, after completing the courses for first two years and 10 weeks' internship, the student becomes eligible for UG-Diploma in Agribusiness Management on exit. The students continuing further for award of the B.Sc. (Hons.) Agribusiness Management need not take the internships after first and second years.
- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given on proper amalgamation of theory and practical to provide them hardcore knowledge of the Agribusiness Management discipline. In the third year, the student will be taught intensive core courses of the discipline.
- Ten credits of online courses are at the discretion of students. Students have the choice of MOOC to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these elective courses of 10 credits throughout the span of the degree Program.
- In seventh semester of the degree Program, students will be required to choose Elective Courses of 20 credits [any five courses of four credits each, from the List of Courses notified by the University].
- In eighth semester of the degree Program, students will be required to complete 20 credits by undergoing Student-READY Program [RAWE/In-plant training/ Industrial attachment/ Experiential Learning/ Hands-on-Training/ Project Work/ Internship/ Attachment to Rand D Institute/ Laboratory, etc.].

Entry and Exit Options

The entry and exit options for the UG program s in Agribusiness Management are shown in the Fig. 1.

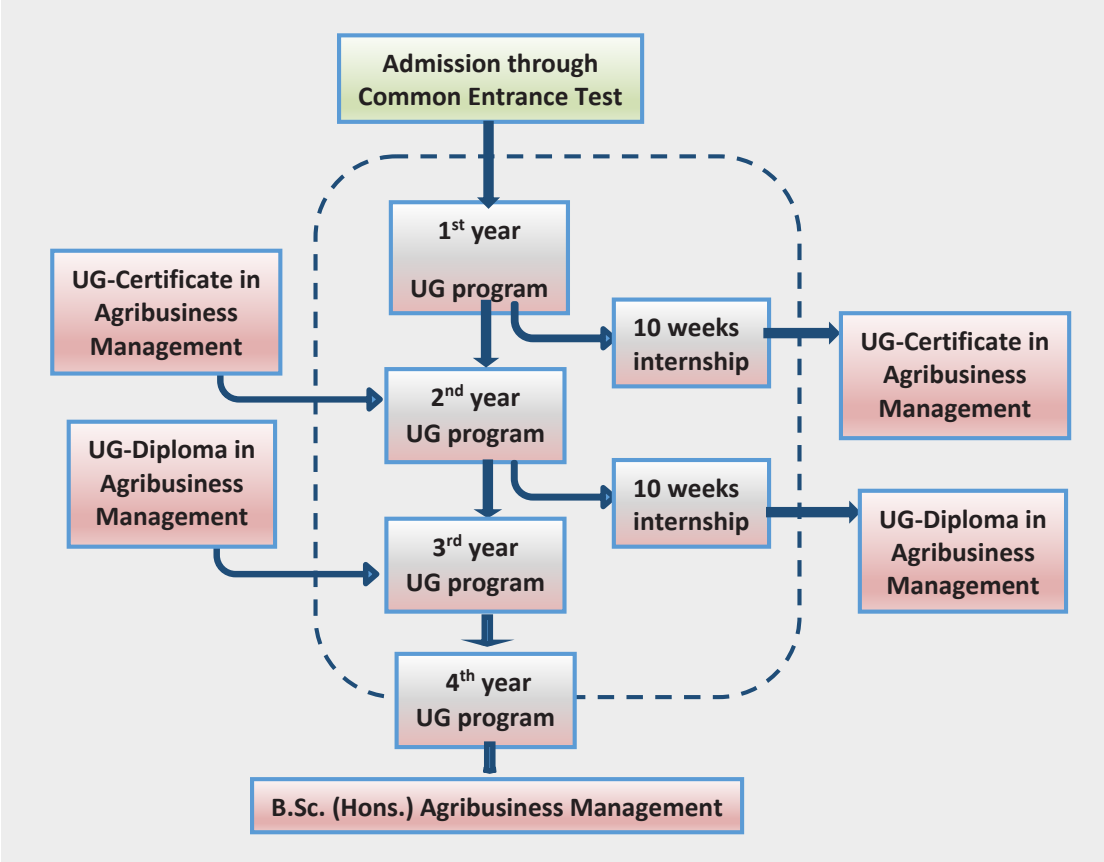

Fig. 1. Schematic representation of restructured B. Sc. (Hons.) Agribusiness Management

Entry: Eligibility for Entry into 1st year UG program

- 10+2 Science with PCMB/PCB/PCM or as per the criteria prescribed by the ICAR/ respective SAU,

  OR

  10+2 Diploma in any branch of Agriculture awarded by any State Agricultural University/ ICAR Institute.
- Selection through Common Entrance Test (CET) / National Entrance Test (NET) or as prescribed by the ICAR/respective SAU, from time to time.

Exit options

UG-Certificate in Agribusiness Management (exit after first year and completion of 10 weeks' internship)

UG-Diploma in Agribusiness Management (exit after second year and completion of 10 weeks' internship)

B.Sc. (Hons.) Agribusiness Management (on successful completion of four-year degree requirements)

ADEMIC PROGRAM

Semester wise course distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	I semester		
1	Deeksharambh (Induction-cum-Foundation Course)	2 (0+2)*	**22 (12+10)+2* (NG)**
2	Introduction to Agribusiness Management	2 (2+0)	
3	Fundamentals of Agricultural Economics	2 (2+0)	
4	Introduction to Agronomy and Crop Production Technology	2 (1+1)	
5	Management of Insect Pests of Crops and Stored Grains	2 (1+1)	
6	Management of Plant Diseases	2 (1+1)	
7	Basic Mathematics/Basic Botany	2 (2+0)	
8	Farming Based Livelihood Systems	3 (2+1)	
9	NCC-I/ NSS-I	1 (0+1)	
10	Communication Skills	2 (1+1)	
11	**SEC-1:** Computer Applications in Agriculture	2 (0+2)	
12	**SEC-2:** Production Technology for Bio-Agents and Bio-fertilizers	2 (0+2)	
	II semester		
1	Farm Management, Production and Resource Economics	3 (2+1)	**23 (10+13)**
2	Marketing of Agricultural Inputs and Outputs	2 (1+1)	
3	Agricultural Finance and Insurance	2 (1+1)	
4	Introduction to Genetics and Plant breeding	2 (1+1)	
5	Principles and Practices of Seed Science and Technology	2 (1+1)	
6	Livestock, Poultry and Fish Production Management	2 (1+1)	
7	Environmental Studies and Disaster Management	3 (2+1)	
8	NCC-II/NSS-II	1 (0+1)	
9	Personality Development	2 (1+1)	
10	**SEC-3:** Seed Production and Seed Testing	2 (0+2)	
11	**SEC-4:** Livestock Production and Management	2 (0+2)	
	Post-Semester II (Only for exit with UG-Certificate in Agribusiness Management)		
1	Internship (10 weeks)	10 (0+10)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
	Second Year		
	III semester		
1	Food Business Management	2 (2+0)	**20 (10+10)**
2	Value Chain and Retail Management in Agribusiness	2 (1+1)	
3	Introduction to Accountancy	3 (2+1)	
4	Soil and Water Management	2 (1+1)	
5	General Horticulture	2 (1+1)	
6	Protected Cultivation and Secondary Agriculture	2 (1+1)	
7	Agricultural Marketing and Trade	3 (2+1)	
8	Physical Education, First Aid and Yoga Practice	2 (0+2)	
9	**SEC-5:** Poultry Production Technology	2 (0+2)	
	IV semester		
1	Business Laws and Ethics	2 (2+0)	**21 (13+8)**
2	International Trade and Policy in Agriculture	2 (2+0)	
3	Agricultural Marketing Regulations	3 (2+1)	
4	Principles of Management and Organizational Behaviour	2 (1+1)	
5	Farm Machinery and Power and Custom Hiring Services	2 (1+1)	
6	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)	
7	Entrepreneurship Development and Business Management	3 (2+1)	
8	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9	**SEC-6:** Development of Agribusiness Proposal	2 (0+2)	
	Post-Semester IV (Only for exit option with UG-Diploma in Agribusiness Management)		
1	Internship (10 weeks)	10 (0+10)	
	Third Year		
	V semester		
1	Grading, Standardization and Quality Management in Agri-food Products	2 (1+1)	**21 (13+8)**
2	Market Information and Intelligence	3 (2+1)	
3	Capital and Commodity Markets	2 (1+1)	
4	Cooperatives and Producers' Organizations	3 (2+1)	
5	Business Research Methods	3 (2+1)	
6	Sustainable Farming Systems and Precision Agriculture	2 (1+1)	
7	Intellectual Property Rights	1 (1+0)	
8	Fundamentals of Plant Biotechnology	2 (2+0)	
9	Social Entrepreneurship	1 (1+0)	
10	Applied Business Statistics	2 (1+1)	
11	Educational Tour (2 Weeks)	2 (0+2)*	

Sl. No.	Course Title	Credit Hours	Total Credit hours
	VI semester		
1	Corporate Social Responsibility and Managerial Ethics	3 (2+1)	**20 (15+5)**
2	Introduction to Managerial Economics	3 (2+1)	
3	Marketing Management	3 (3+0)	
4	Agribusiness Project Management	3 (2+1)	
5	Strategic Business Management	3 (2+1)	
6	Rural Marketing	3 (2+1)	
7	Commodity Futures Trading	2 (2+0)	
	Fourth Year		
	VII semester		
1	Electives [Student has to choose a minimum of 20 credits from the list of elective courses notified by the University]	20	
	VIII semester		
1	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/ Internship/ Attachment to Rand D Institute/ Laboratory, etc.]	20	

*Non-gradial

Department/section wise course breakup

SN	Course Title	Credit Hours
I	**AGRIBUSINESS MANAGEMENT and AGRICULTURAL ECONOMICS**	
1	Introduction to Agribusiness Management	2 (2+0)
2	Marketing of Agricultural Inputs and Outputs	2 (1+1)
3	Agricultural Finance and Insurance	2 (1+1)
4	Food Business Management	2 (2+0)
5	Value Chain and Retail Management in Agribusiness	2 (1+1)
6	Introduction to Accountancy	3 (2+1)
7	Business Laws and Ethics	2 (2+0)
8	International Trade and Policy in Agriculture	2 (2+0)
9	Agricultural Marketing Regulations	3 (2+1)
10	Principles of Management and Organizational Behaviour	2 (1+1)
11	Grading, Standardization and Quality Management in Agri-food Products	2 (1+1)
12	Market Information and Intelligence	3 (2+1)
13	Capital and Commodity Markets	2 (1+1)
14	Cooperatives and Producers' Organizations	3 (2+1)
15	Business Research Methods	3 (2+1)

SN	Course Title	Credit Hours
16	Corporate Social Responsibility and Managerial Ethics	3 (2+1)
17	Introduction to Managerial Economics	3 (2+1)
18	Marketing Management	3 (3+0)
19	Agribusiness Project Management	3 (2+1)
20	Strategic Business Management	3 (2+1)
21	Rural Marketing	3 (2+1)
22	Commodity Futures Trading	2 (2+0)
23	Entrepreneurship Development and Business Management	3 (2+1)
24	Agricultural Marketing and Trade	3 (2+1)
25	Fundamentals of Agricultural Economics	2 (2+0)
26	Farm Management, Production and Resource Economics	3 (2+1)
27	Development of Agribusiness Proposal	2 (0+2)
28	Agro-Tourism	4 (0+4)
29	Seed Business Management	4 (0+4)
30	Fertilizer Retailing	4 (0+4)
31	Food Retail Business Management	4 (0+4)
32	Supply Chain Management of Agricultural Commodities	4 (0+4)
33	Agri-Export Management	4 (0+4)
34	Hi-Tech Horticulture/Protected Cultivation	4 (0+4)
35	Packaging and Branding of Agricultural Commodities	4 (0+4)
36	e-Commerce in Agribusiness	4 (0+4)
37	Storage and Warehousing of Agricultural Commodities	4 (0+4)
38	Logistics Management of Agricultural Commodities	4 (0+4)
39	Custom Hiring of Agricultural Machinery	4 (0+4)
40	Application of ICT in Agribusiness	4 (0+4)
41	Value Addition to Agricultural Commodities	4 (0+4)
42	Financial Management	4 (0+4)
II	**AGRICULTURAL SCIENCES**	
1	Introduction to Genetics and Plant Breeding	2 (1+1)
2	Intellectual Property Rights	1 (1+0)
3	Introduction to Agronomy and Crop Production Technology	2 (1+1)
4	Sustainable Farming Systems and Precision Agriculture	2 (1+1)
5	Farming Based Livelihood Systems	3 (2+1)
6	Soil and Water Management	2 (1+1)
7	Management of Insect Pests of Crops and Stored Grains	2 (1+1)
8	Management of Plant Diseases	2 (1+1)

SN	Course Title	Credit Hours
9	Principles and Practices of Seed Science and Technology	2 (1+1)
10	General Horticulture	2 (1+1)
11	Protected Cultivation and Secondary Agriculture	2 (1+1)
12	Post-Harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
13	Farm Machinery and Power and Custom Hiring Services	2 (1+1)
14	Fundamentals of Plant Biotechnology	2 (2+0)
15	Social Entrepreneurship	1 (1+0)
16	Environmental Studies and Disaster Management	3 (2+1)
17	Production Technology for Bio-Agents and Bio-Fertilizers	2 (0+2)
18	Seed Production and Seed Testing	2 (0+2)
III	**ANIMAL SCIENCES**	
1	Livestock, Poultry and Fish Production Management	2 (1+1)
2	Livestock Production and Management	2 (0+2)
3	Poultry Production Technology	2 (0+2)
IV	**BASIC SCIENCES**	
1	Basic Mathematics/Basic Botany	2 (2+0)
2	Applied Business Statistics	2 (1+1)
3	Agricultural Informatics and Artificial Intelligence	3 (2+1)
4	Computer Applications in Agriculture	2 (0+2)
V	**GENERAL SCIENCES**	
1	NCC(1) / NSS(1)	1 (0+1)
2	NCC(2) / NSS(2)	1 (0+1)
3	Communication Skills	2 (1+1)
4	Personality Development	2 (1+1)
5	Physical Education, First Aid and Yoga Practice	2 (0+2)
VI	**INTERNSHIP / TRAINING COURSES**	
1	Internship [Only for exiting students after Second/Fourth Semester for Certificate Course/Diploma, if applicable]	10 (0+10)
2	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/Internship/Attachment to Rand D Institute/Laboratory]	20 (0+20)
VII	**NON-GRADIAL COURSES**	
1	*Deeksharambh* [Induction-cum-Foundation Course (2 weeks)]	2 (0+2)
2	Educational Tour (2 weeks)	2 (0+2)
VIII	**ONLINE COURSES**	
1	MOOCs/Online Courses	10

Category-wise Course Distribution

S. N.	Course Title	No. of Courses	Total Credits
I	**MAJOR COURSES**	**24**	**60 (43+17)**
1	Introduction to Agribusiness Management		2 (2+0)
2	Fundamentals of Agricultural Economics		2 (2+0)
3	Farm Management, Production and Resource Economics		3 (2+1)
4	Marketing of Agricultural Inputs and Outputs		2 (1+1)
5	Agricultural Finance and Insurance		2 (1+1)
6	Food Business Management		2 (2+0)
7	Value chain and Retail Management in Agribusiness		2 (1+1)
8	Introduction to Accountancy		3 (2+1)
9	Business Laws and Ethics		2 (2+0)
10	International Trade and Policy in Agriculture		2 (2+0)
11	Agricultural Marketing Regulations		3 (2+1)
12	Principles of Management and Organizational Behaviour		2 (1+1)
13	Grading, Standardization and Quality Management in Agri-food Products		2 (1+1)
14	Market Information and Intelligence		3 (2+1)
15	Capital and Commodity Markets		2 (1+1)
16	Cooperatives and Producers' Organizations		3 (2+1)
17	Business Research Methods		3 (2+1)
18	Corporate Social Responsibility and Managerial Ethics		3 (2+1)
19	Introduction to Managerial Economics		3 (2+1)
20	Marketing Management		3 (3+0)
21	Agribusiness Project Management		3 (2+1)
22	Strategic Business Management		3 (2+1)
23	Rural Marketing		3 (2+1)
24	Commodity Futures Trading		2 (2+0)
II	**MINOR COURSES**	**17**	**32 (19+13)**
1	Introduction to Agronomy and Crop Production Technology		2 (1+1)
2	Management of Insect Pests of Crops and Stored Grains		2 (1+1)
3	Management of Plant Diseases		2 (1+1)
4	Basic Mathematics/Basic Botany		2 (2+0)
5	Introduction to Genetics and Plant Breeding		2 (1+1)
6	Principles and Practices of Seed Science and Technology		2 (1+1)
7	Livestock, Poultry and Fish Production Management		2 (1+1)
8	Soil and Water Management		2 (1+1)
9	General Horticulture		2 (1+1)
10	Protected Cultivation and Secondary Agriculture		2 (1+1)
11	Farm Machinery and Power and Custom Hiring Services		2 (1+1)

S. N.	Course Title	No. of Courses	Total Credits
12	Post-Harvest Management and Value Addition of Fruits and Vegetables		2 (1+1)
13	Sustainable Farming Systems and Precision Agriculture		2 (1+1)
14	Intellectual Property Rights		1 (1+0)
15	Fundamentals of Plant Biotechnology		2 (2+0)
16	Social Entrepreneurship		1 (1+0)
17	Applied Business Statistics		2 (1+1)
III	**MULTI-DISCIPLINARY COURSES (MDC)**	**3**	**9 (6+3)**
1	Farming Based Livelihood Systems		3 (2+1)
2	Agricultural Marketing and Trade		3 (2+1)
3	Entrepreneurship Development and Business Management		3 (2+1)
IV	**VALUE ADDED COURSES (VAC)**	**2**	**6 (4+2)**
1	Environmental Studies and Disaster Management		3 (2+1)
2	Agricultural Informatics and Artificial Intelligence		3 (2+1)
V	**ABILITY ENHANCEMENT COURSES (AEC)**	**5**	**8 (2+6)**
1	NCC(1) / NSS(1)		1 (0+1)
2	NCC(2) / NSS(2)		1 (0+1)
3	Communication Skills		2 (1+1)
4	Personality Development		2 (1+1)
5	Physical Education, First Aid and Yoga Practice		2 (0+2)
VI	**SKILL ENHANCEMENT COURSES (SEC)**	**6**	**12 (0+12)**
1	Computer Applications in Agriculture		2 (0+2)
2	Production Technology for Bio-Agents and Bio-Fertilizers		2 (0+2)
3	Seed Production and Seed Testing		2 (0+2)
4	Livestock Production and Management		2 (0+2)
5	Poultry Production Technology		2 (0+2)
6	Development of Agribusiness Proposal		2 (0+2)
VII	**ELECTIVES (ELC)**		**20**
VIII	**PROJECT / TRAINING COURSES (PTC)**		**20**
1	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/Internship/ Attachment to Rand D Institute/Laboratory]		
IX	**INTERNSHIP COURSES (ISC)**	**1**	**10 (0+10)**
1	Internship [Only for exiting students after Second/Fourth Semester for Certificate Course/Diploma, if applicable]		10 (0+10)
X	**NON-GRADIAL COURSES (NGC)**	**2**	**4 (0+4)**
1	*Deeksharambh* [Induction-cum-Foundation Course (2 weeks)]		2 (0+2)
2	Educational Tour (2 weeks)		2 (0+2)
XI	**ONLINE COURSES / MOOCs (OLC)**		**10**
	TOTAL		**167+4*+10#**

*Non-Gradial Courses; #Online/MOOC Courses.

Table 1. Credits Allocation Scheme of UG Agribusiness Management Program (Credit Hours)

Semester	Core Courses-Major	Core Courses-Minor	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Project/ Training/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses (MOOC)
I	4	8	3[1]	-	1[2] + 2[3]	4	-	**22**	2[4]	-	
II	7	6	-	3[5]	1[6] + 2[7]	4	-	**23**	-	-	
Post-II	-	-	-	-	-	-	-	**-**	-	10[8]	
III	7	6	3[9]	-	2[10]	2	-	**20**	-	-	
IV	9	4	3[11]	3[12]	-	2	-	**21**	-	-	**10[18]**
Post-IV	-	-	-	-	-	-	-	**-**	-	10[13]	
V	13	8	-	-	-	-	-	**21**	2[14]	-	
VI	20	-	-	-	-	-	-	**20**	-	-	
VII	20[15]	-	-	-	-	-	-	**20**	-	-	
VIII	-	-	-	-	-	-	20[16]	**20**	-	-	
Total	**80**	**32**	**9**	**6**	**8**	**12**	**20[16]**	**167**	**4[17]**		**10[18]**

(1) Farming based Livelihood systems
(2) National Cadet Corps-I (NCC-I) / National Service Scheme-I (NSS-I)
(3) Communication Skills
(4) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(5) Environmental Studies and Disaster Management
(6) National Cadet Corps-II (NCC-II) / National Service Scheme-II (NSS-II)
(7) Personality Development
(8) Internship of 10 credits of to be completed by exiting students after Second Semester to get UG-Certificate in Agribusiness Management
(9) Agricultural Marketing and Trade
(10) Physical Education, First Aid and Yoga Practice
(11) Entrepreneurship Development and Business Management
(12) Agricultural Informatics and Artificial Intelligence.
(13) Internship of 10 credits to be completed by exiting students after Fourth Semester to get UG-Diploma in Agribusiness Management
(14) Educational Tour of 2 weeks duration
(15) Electives of a minimum of 20 credits to be chosen from the list of courses announced by the University.
(16) Student-READY Program [including RAWE/In-plant training/Industrial attachment/Experiential Learning/Hands-on-Training/Project Work/Internship/Attachment to Rand D Institute/Laboratory].
(17) Non-Gradial Courses
(18) Online courses of a minimum of 10 credits (from MOOCS/ SWAYAM/etc.) shall be chosen by the student with the permission of the Dean of the College.

Summary of Credit Distribution

Type of courses	Credits
Core courses (major and minor/s)	112
Common courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Internship / Student READY	20
**Online Courses / MOOCs	10**
Total	**167 + 10****

DETAILED SYLLABI

Semester I

Deeksharambh [Induction-cum-Foundation Course (2 Weeks)] 2 (0+2)

Objective

- To create a platform for students to (i) help for cultural integration of students from different backgrounds; (ii) know about the operational framework of academic process in university; (iii) instilling life and social skills; (iv) social awareness, ethics and values, team work, leadership, creativity, etc., (v) identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

Practical

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on operational framework of academic process in University, as well as interactions with academic and research managers of the University.
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences.
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences.
- Activities to enhance cultural Integration of students from different backgrounds.
- Field visits to related fields/ establishments.
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.

Introduction to Agribusiness Management 2 (2+0)

Objectives

1. To gain a comprehensive understanding of agribusiness structures, functions, and dynamics
2. To develop essential management skills applicable to agricultural enterprises

3. To explore strategies for optimizing production efficiency and maximizing profitability in agribusiness
4. To prepare for diverse careers in farm management, agricultural marketing, finance, and consulting

Theory

Indian Agriculture: Place of Agriculture in Indian Economy, trends in the structure of Indian Economy, Role of Agriculture in Economic Development in India. Trends in agricultural production and productivity, cropping pattern size of farms and farm efficiency. Functions of Management – Planning, organizing, staffing, motivation and control and Principles of Management. Indian agriculture: Impact of Liberalization, Privatization and Globalization on Agribusiness sector. Agribusiness Management: Definition, importance, Scope of Agribusiness Management, Agribusiness Management- Nature, definition, scope and functions. Agribusiness input and output services, Agricultural credit and foreign trade, Planning and Organizing agribusiness. New trends in Agribusiness: Contract farming, Types and scope of contract farming, Working of contracts, Contract models, Organic farming, Genetically modified food, Farmer Producers' Organizations (FPO) Case Studies.

Suggested Readings

1. Farm Business Management: The Fundamentals of Good Practice by Peter L Nuthall.
2. Fundamentals of Agribusiness Finance by Ralph W. Battles and Robert C Thompson.
3. Objective Agribusiness Management by S R Panigrahy.
4. Agribusiness: Management, Marketing, Human Resource Development, Communication, and Technology by Robert H Usry and Lanny W Hass.
5. Agribusiness and Market Management by Amod Sharma.

Fundamentals of Agricultural Economics 2 (2+0)

Objectives

1. To understand the fundamental principles of economics as they apply to agriculture;
2. To analyze the economic factors influencing agricultural production, distribution, and consumption.
3. To explore the role of government policies and international trade in shaping the agricultural economy.
4. To develop critical thinking skills to evaluate and address economic challenges and opportunities in agriculture.

Theory

Agricultural Economics: Meaning, definition, characteristics of agriculture, Nature and scope of agricultural economics, Distinction between agriculture and industry, Role of agriculture in economic development, Role of government interventions in agricultural development. Planning and Agricultural Development: Meaning and objectives, economic planning, benefits of planning, Agricultural development during different Five year Plans in India, Measures of reorganization of agriculture and NITI Aayog. Factors of production: Meaning of land and its characteristics, Labour

concept, Characteristics of labour and efficiency of labour, Capital concept and its characteristics, Forms of capital in agriculture and process of capital formation, Organization of business firms, Forms of business organizations and their characteristics. Land reforms: Land reforms and Land tenure systems, Concepts of agricultural land holdings in India. Theory of production: Meaning, definition, types of production functions, Laws of Diminishing Marginal Returns and Elasticity of production. Scale of production: Meaning, classification and economies of scale. Theory of costs: Meaning, definitions and different types of costs and their measurement. Revenue concept: Total revenue, average revenue and marginal revenue and profit maximization.

Suggested Readings

1. Agriculture economics by Shubha Reddy
2. Finance by Shubha Reddy
3. Economic of farm production and management by VT Raju, VS Rao
4. Agricultural marketing in India by S S Acharya, NL Aggarwal
5. Modern microeconomics by Koutsoyiannis

Introduction to Agronomy and Crop Production Technology 2 (1+1)

Objectives

1. To understand the principles of agronomy and crop production technology.
2. To learn about crop growth and development, including factors influencing yield and quality.
3. To explore sustainable and efficient farming practices to enhance crop productivity while minimizing environmental impact.
4. To gain practical knowledge of crop management techniques, including soil fertility, pest control, and irrigation.

Theory

Agriculture**,** Agronomy and their scope, tillage and tilth, crop density and geometry, factors affecting growth and development, crops and cropping systems, crop rotation and its principles, manures and fertilizers, irrigation, water resources, crop water requirement, water-use efficiency, irrigation-scheduling criteria and methods, quality of irrigation water, drainage. Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides. Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops, namely, rice, maize, sorghum, minor millets, pigeon pea, mung bean, groundnut and soybean. *Rabi* crops, namely, sorghum, wheat, chickpea, rapeseed and mustard, sunflower, sugarcane, cotton, tobacco and chilli.

Practical

Identification of crops, seeds, fertilizers, herbicides, tillage and sowing implements, Identification of weeds in crops, Methods of herbicide and fertilizer application, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Methods of irrigation. Methods of sowing of different crops. Nutrient functions and deficiencies, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of important crops, Visit to research centers of related crops.

Suggested Readings

1. Principles of Agronomy by T.Y. Reddy and G.H. Sankara Reddi*: This book provides a comprehensive overview of agronomy principles, including crop production techniques, soil management, and crop physiology.
2. Fundamentals of Crop Production by Stephen R. Kaffka and Larry L. Strand*: This textbook covers the basics of crop production, including plant growth and development, crop management practices, and environmental factors affecting crop yield.
3. Introduction to Agricultural Engineering Technology: A Problem Solving Approach by Harry L. Field and John B. Solie*: This book offers insights into the technological aspects of agronomy, including machinery, irrigation systems, and precision agriculture techniques.
4. Crop Production: Evolution, History, and Technology by C. Wayne Smith and Julian R. Betters*: This book explores the history and evolution of crop production technologies, providing a broader context for understanding modern agronomy practices.

Management of Insect Pests of Crops and Stored Grains 2 (1+1)

Objectives

1. To understand the biology, ecology, and behavior of insect pests affecting crops and stored grains.
2. To learn effective strategies for monitoring, prevention, and control of insect pests in agricultural settings.
3. To explore integrated pest management (IPM) approaches, including biological, cultural, and chemical control methods.
4. To develop skills to assess and minimize economic losses caused by insect pests while promoting sustainable agriculture practices.

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage and management of major pests of various field and horticulture crops. Factors affecting losses of stored grain. Insect pests, mites, rodents and birds associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification of various insect pests attacking different crops. Identification of insect pests associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grains in store / godown. Identification of rodents and rodent control operations. Identification of birds and bird control operations. Methods of grain sampling under storage condition. Visit to nearest FCI godowns and ware houses.

Note: Each student should submit 25 insect pests representing different crops and stored products.

Suggested Readings

1. Bhargava and Kumawati. Pest of stored grains and their management.
2. Dhaliwal G. S. and Koul Opender. Bio pesticides and pest management.
3. Dhaliwal G.S. and Arora Ramesh. 1998. Principles of insect pest management. Kalyani Publisher, 297p.
4. Dhaliwal G.S. and Heinrichs E. A. 1998. Critical issues in pest management. Common Wealth Publisher, New Delhi, 287p.
5. Hameed S. F. and Singh S. P. Handbook of pest management.
6. Marwaha K. K., Siddiqui K. H. and Singh J. P. Hand. book of crop pest control.
7. Panwar V. P. S. Agricultural insect pests of crops and their management.
8. Ranjith A. M. Identification and management of horticultural pest.
9. Sharma Ramnivas. Identification and management of horticulture pest.
10. Srivastav K. P. and Ahlawat Y. S. Pest management in citrus.

Management of Plant Diseases 2 (1+1)

Objectives

1. To understand the biology, epidemiology, and ecology of plant diseases.
2. To learn effective strategies for disease prevention, diagnosis, and management in agricultural systems.
3. To explore integrated disease management approaches, including cultural, chemical, and biological control methods.
4. To develop skills to mitigate the impact of plant diseases on crop yield, quality, and sustainability.

Theory

Objectives, historical development and economic significance of post-harvest diseases and seed-borne diseases. Study of important post-harvest diseases (transport, storage and market) of perishables and grains etc. Production of mycotoxins and their effects. Diagnosis and detection of plant pathogens carried through seeds, vegetatively propagated material. Harvesting, transportation, processing and methods of storage. Seed contamination, seed-borne infections and seed transmission. Packing and packaging, requirement of packing materials. Principles of plant disease management, viz., avoidance, exclusion, eradication, protection, immunization-HPR and biological control. Pesticides, Classification of fungicides. Mode of application. Biotechnological approaches of diseases management. IPR and related issues. IDM concepts and importance. Management of post-harvest diseases. IDM module for important post-harvest diseases.

Practical

Study of post-harvest disease symptoms caused by fungi, bacteria, virus, nematodes etc. Diagnosis and detection of various post-harvest diseases. Methods of detection and identification of seed-borne pathogens, isolation of biocontrol agents, Testing the efficacy of biocontrol agents by dual culture technique. Mass multiplication and methods of application of bio agents, Study of fungicides, bactericides, nematicides and their formulations. Study of pesticide compatibility

and their safe-use. Study of plant protection equipments. Bioassay of fungicides, Seed treatment techniques for the control of seed-borne diseases. Biocontrol of post-harvest diseases. Study of seed packaging and storage techniques. Visit to vegetable and fruit markets, bio-pesticide/ pesticide firms. Visit to processing warehouse and testing laboratories.

Suggested Readings

1. Butani, D.K. 1984. Insects and fruits. Periodical Expert Book Agency, New Delhi.
2. Jonathan, E.I., Cannayane, I., Devrajan, K., Kumar, S. and Ramakrishan, S. Agricultural nematology. TNAU, Coimbatore.
3. Metcalf, R.L. and Luckman, W.H. 1982. Introduction to insect pest management. Wiley Inter Science Publishing, New York.
4. Nair, M.R.G.K. 1975. Insects and mites of crops in India. ICAR, New Delhi.
5. Swaroop, Gopal and Das, Gupta. 1986. Plant parasitic nematodes of India: Problems and progress. ICAR, New Delhi.
6. Upadhyay, K.D. and Dwivedi, K. 1997. A textbook of plant nematology. Aman publishing house, Meerut
7. Vasanth Raju David, B. 2001. Elements of economic entomology. Popular Book Depot, Chennai.

Basic Mathematics / Botany 2 (2+0)

Basic Mathematics

Objective

To introduce the basic principles and functions in mathematics

Theory

Algebra: Progressions - Arithmetic, Geometric and Harmonic Progressions. Matrices- Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation-Growth rate, Average Cost, Marginal Cost, Marginal Revenue. Partial differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form y = f (x) and y = f (x1, x2).

Integral Calculus: Integration - Definite and Indefinite Integrals, Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

Basic Botany

Objective

To introduces the basic taxonomy and classification of plants

Theory

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination.

Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf.

Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Suggested Readings

1. Bendre AM and Kumar A, 1999, Textbook of practical botany. Vol. 2, 7th Ed, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to botany. Rastogi publications.
3. Bhatia KN and Tyagi MP, 2020, Elementary biology. Truemen Publication.
4. David M Hillis; H Craig Heller; Sally D Hacker; David W Hall and David E Sadava, 2020, Life: The science of biology. 12th ed. Sunderland Publication. eBook.
5. Dutta AC, 1995, A Class Book of Botany, 16th Ed. Oxford University Press.
6. NCERT, 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A textbook of Botany Angiosperm. S. Chand Publications.

Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states. Income of farmers and rural people in India. Livelihood-definition, concept and livelihood pattern in urban and rural areas. Different indicators to study livelihood systems. Agricultural livelihood systems (ALS); meaning, approach, approaches and framework. Definition of farming systems and farming based livelihood systems, prevalent farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- crops and cropping systems, livestock (dairy, piggery, goatry, poultry, duckry etc.), horticultural crops, agroforestry systems, aquaculture, duck/poultry-cum-fish, dairy-cum-fish, piggery-cum-fish etc. Evaluation indices for cropping system and farming systems. Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers. Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different

agro-climatic zones. Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country. Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems. Schemes and program s by central and state government, public and private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises. Study of components of important farming-based livelihood models/ systems in different agro-climatic zones. Study of production and profitability of crop-based, livestock-based, processing-based and integrated farming-based livelihood models. Field visit of innovative farming system models. Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and study of agri-enterprises involved in industry and service sectors (value chain models). Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis. Evaluation indices for cropping system and farming systems. Case study of start-ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S, 1989, Towards Green Villages: A Strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D, 1999, Sustainable Livelihoods: Lessons from Early Experience. Department for International Development: London, UK, Volume 7.
3. Bhatt BP, Abhay Kumar, Thakur PK, RS, Amitava Dey UK, Sanjeev Kumar BK, Jha, LK, Pathak KN, Hassan A, Singh SK, Singh KK and Singh KM, 2014, Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar. ICAR Research Complex for Eastern Region, ICAR Parisar, P.O. Bihar Veterinary College, Patna, Bihar.
4. Carloni A, 2001, Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa. Consultation Document, FAO, Rome, Italy.
5. Dixon J, Gulliver A and Gibbon D, 2001, Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank: Rome, Italy and Washington, DC, USA.
6. Evenson RE, 2000, Agricultural Productivity and Production in Developing Countries'. The State of Food and Agriculture, FAO, Rome, Italy.
7. Panwar AS, Ravisankar N, Prusty AK, Shamim M, Singh R, Bhaskar S, Malik SK, Tomar RK, Arunachalam A and Alagusundaram K, 2019, Integrated Farming System models for Agricultural Diversification, Enhanced Income and Employment. Indian Council of Agricultural Research, New Delhi.
8. Reddy SR, 2016, Farming System and Sustainable Agriculture. Kalyani Publishers, New Delhi.
9. Singh JP, Ravisankar N, Prusty AK, Sikka AK and Gangwar B, 2016, Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series 1). IIFSR Bulletin No. 2016-1, AICRP on Integrated Farming Systems, ICAR-Indian

Institute of Farming Systems Research, Modipuram, Meerut, pp. 1-88.

10. Walia SS and Walia US, 2020, Farming System and Sustainable Agriculture. Scientific Publishers, Jodhpur, Rajasthan.

National Cadet Corps-I (NCC-I) 1 (0+1)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline. Drill- aim, general words of command, attention, stands at ease, stand easy and turning. sizing, numbering, forming in three ranks, open and close order march, and dressing. Saluting at the halt, getting on parade, dismissing, and falling out. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. Marking time, forward march, and halt. Changing step, formation of squad and squad drill. Command and control, organization, badges of rank, honors, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme-I (NSS-I) 1 (0+1)

Objectives

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work; to be skilful in executing democratic leadership; developing skill in program; to be able to seek self-employment, reducing gap between educated and uneducated; increasing awareness and desire to help sections of society.

Practical

Orientation: history, objectives, principles, symbol, badge; regular Program s under NSS. Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered

by NSS volunteers' awareness about health. NSS Program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth Program / schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is the agent of social change. Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace- building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism. Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication process: The magic of effective communication. Building self-esteem and overcoming fears. Concept, nature and significance of communication process. Meaning, types and models of communication. Verbal and non-verbal communication. Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic communication skills. Listening, speaking, reading and writing skills. Precise writing/ abstracting/summarizing. Style of technical communication. Curriculum vitae/resume writing. Innovative methods to enhance vocabulary, analogy questions.

Structural and functional grammar. Sentence structure, modifiers, connecting words and verbals. Phrases and clauses. Case: subjective case, possessive case, objective case. Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles. Agreement of verb with the subject: tense, mood, voice. Writing effective sentences. Basic sentence faults.

Practical

Listening and note taking. Writing skills; precise writing, summarizing and abstracting. Reading and comprehension (written and oral) of general and technical articles. Micro-presentations and impromptu presentations. Feedback on presentations. Stage manners; grooming, body language, voice modulation, speed. Group discussions. Public speaking exercises; vocabulary building exercises. Interview techniques. Organization of events.

Suggested Readings

1. Allport GW, 1937, Personality: A Psychological Interpretation, Holt, New York.
2. Brown M and Gyles B, 1994, How to Interview and be Interviewed, Sheldon Press, London.
3. Carnegie D, 1997, The Quick and Easy Way to Effective Speaking, Pocket Books, New York.

4. Francis Peter SJ, 2012, Soft Skills and Professional Communication, Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills, Oxford University Press.
6. Neuliep JW, 2003, Intercultural Communication: A Contextual Approach, Houghton Mifflin Co Boston.
7. Pease A, 1998, Body Language, Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication, Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking, Oxford University Press.
10. Thomson AJ and Martinet AV, 1977, A Practical English Grammar, Oxford University.

SEC-1: Computer Applications in Agriculture 2 (0+2)

Objectives

1. To understand the role of computer applications in modern agricultural practices.
2. To learn to use agricultural software and tools for data analysis, modeling, and decision-making.
3. To explore the application of Geographic Information Systems (GIS) and remote sensing in precision agriculture.
4. To develop skills in utilizing technology to optimize farm management, improve productivity, and reduce environmental impact.

Practical

Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management program. Use of electronic spreadsheet and graphics. Use of SPSS statistical application packages. Use of SAS in agriculture and its application. Working with MS-DOS. Database design. Data entry operation. Use of electronic spreadsheet and graphics. Basics of computer networking – LAN, SAN – BUS – Tokening – Star - Internet, Intranet – Basics of Email – Exposure to web browsing (structure of URL), Types of websites – Internet service provider – using internet news.

Suggested Readings

1. Computers in Agriculture: Fundamentals and Applications (Hardcover – 20 October 2016) by Sharma Manish, Anil Bhatt
2. Computer Applications in Agriculture By William Otto Rasmussen.
3. Computer Applications in Agriculture and Agribusiness (Paperback – Import, 1 June 1994) by Michael E. Newman (Author).

SEC-2: Production Technology for Bio-Agents and Bio-Fertilizers 2 (0+2

Objectives

1. To understand the principles and methods of producing bio-agents and bio-fertilizers.
2. To learn techniques for mass production and formulation of beneficial microorganisms.
3. To explore the role of bio-agents and bio-fertilizers in sustainable agriculture and soil health management.

4. To develop skills to integrate bio-agents and bio-fertilizers into crop production systems for enhanced yield and reduced environmental impact.

Practical

A. Agricultural Microbiology: Relevance of Biofertilizer in Agriculture. Types of Biofertilizers [(a) Nitrogen fixers: *Rhizobium, Azotobacter, Azospirillum*, *Glucano* acetobacter, Cyanobacteria and Azolla; (b) P-solubilizers: PSB, PSF; (c) K-solubilizers; (d) Zn-solubilizers; (e) P-mobilizers: AM fungi; (f) Development of consortia]. Mass Production Techniques [(a) Carrier based; (b) Liquid Biofertilizers]. Methods of application. Quality Control (Standards as per FCO (1985) amended in 2009).

Suggested Readings

- Atlas Bartha. Microbial Ecology - Fundamentals and Application. Pearson (Fourth edn).
- Bhoopander Giri, Ram Prasad *et al.* Biofertilizers for Sustainable Agriculture and Environment (Soil Biology Book 55).
- Bikas R. Pati and Santi M. Mandal. Recent Trends in Biofertilizers.
- Eiri Board. Handbook of Biofertilizers and Vermiculture. 1 January 2009.
- Himadri Panda. Complete Technology Book on Biofertilizer and Organic Farming.
- J. Nicklin, K. Graeme-Cook, T. Paget and R. Killington. Instant Notes in Microbiology. Viva.
- M K Rai. Handbook of Microbial Biofertilizers.
- Mark S. Coyne. Soil Microbiology - An Exploratory Approach. Delmar Publishers-2004
- Michael Madigan, John Martinko, David Stahl and David Clark. Brock-Biology of Microorganisms. Pearson (Thirteen Edition).

B. Agricultural Entomology: Importance of biopesticides and other non-chemical approaches in pest management. Mass production of laboratory host, parasitoids and predators. Mass rearing techniques of rice moth, *Corcyra cephalonica* Stainton, *Trichigramma* Spp, *Goniozus nephantidis* (Muesebeck) and *Bracon bravicornins* Wesmael, predators, *Chrysoperla zastrowi* Sillemi (Esben-Petersen), *Cryptolaemus montrouzieri* Mulsant, *Micromus igorotus* Banks, Weed killers, *Zygogramma bicolorata* Pallister, Aquatic weed killer, *Cyrtobagous salviniae* Calder, Preparation of culture media, culturing and spore counting of *Nomuraea rileyi* (Farl.) *Samsonand Beauveria bassiana* (Bals.) / *Metarhizium anisopliae* (Met.) and *Lecanicillium lecanii* (Zimmerman), Mas production of Ha NPV/Sl NPV, Estimation of spore load from microbial pesticides, Preparation of Neem Seed Kernel Extract (NSKE), Preparation and use of Biodigester, Panchagavvya, GCK, cow urine and cow dung, Conservation measures for Natural Enemies and visit to Biocontrol Laboratories.

Suggested Readings

- Koul O, Dhaliwal GS and Khokhar S. Biopesticides in Sustainable Agriculture Progress and Potential. Hardcover – 1 January 2014.
- Veeresh GK, Shivashankar K and Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bengaluru.
- WHO. 1990. Public Health Impact of Pesticides Used in Agriculture.WHO.
- Woolmer PL and Swift MJ. 1994. The Biological Management of Tropical Soil Fertility. TSBF and Wiley.

C. Plant Pathology: Introduction about bio-pesticides/global scenario/advantages, disadvantages and mechanisms of action; Isolation and enumeration of fungal biocontrol agents from soil; Isolation and enumeration of bacterial biocontrol agents from soil; Purification of biocontrol agents; Hands on skills on mass production of *Trichoderma harzianum* and *Pacelomyces lilacinus* (isolation, preparation of mother culture, sterilisation, fermentation, quality analysis, mixing, packing and labeling); Characterization of fungal (*Trichoderma harzianum* and *Pacelomyces lilacinus*) antagonistic organisms (Morphological); Studies on antagonistic ability of fungal biocontrol agents through dual plate technique; Hands on skills on mass production of *Pseudomonas fluorescens* and *Bacillus subtilis* (isolation, preparation of mother culture, sterilisation, fermentation, quality analysis, mixing, packing and labeling); Characterization of bacterial (*Pseudomonas fluorescens* and *Bacillus subtilis*) antagonistic organisms (Morphological); Studies on antagonistic ability of bacterial biocontrol agents through dual plate technique; Field evaluation of biocontrol agents; Evaluation of biocontrol agents against diseases of vegetables under protected cultivation; Evaluation of plant extracts (neem, tulsi, pongamia, etc) and liquid organic manures (panchagavya, beejamruta, Jeevamruta) against plant diseases; Registration procedures for biocontrol agents; Cost of production of various biocontrol agents.

Suggested Readings

1. Advances in Plant Biopesticides - Dwijendra Singh.
2. Biopesticides: Use and Delivery - Franklin R. Hall and Julius J. Menn.
3. Biopesticides - Pranab Dutta.

Semester II

Farm Management, Production and Resource Economics 3 (2+1)

Objectives

1. To understand the principles of farm management and resource allocation in agriculture
2. To analyze production economics to optimize resource use and maximize profitability on farms
3. To learn about farm-level decision-making processes, including crop selection, input use, and technology adoption
4. To explore the economic aspects of resource management, including land, labor, capital, and risk, in agricultural enterprises

Theory

Farm management: meaning, definitions and concepts; Nature and scope, objectives and relationship with other sciences; Decisions making process; Meaning and definition of farms sizes based on holding and ownership; Types of farming and their characteristics; factors determining types and size of farms; production economics and farm management principles; Meaning definition of production economics, concept of production function and its types, use of production function in decision making on a farm, factor-product, factor-factor and product-product relationship. Law of equi-marginal returns or principles of opportunity cost and law of comparative advantage; Cost principle: meaning and concept of costs, types of costs-seven costs and applied cost concepts, and their interrelationship, importance of cost in managing farm business; Farm records: types and importance of farm records and accounts in managing a farm; Farm planning and budgeting:

meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting, linear programming; Risk and uncertainty: concept of risk and uncertainty in agriculture production, types/sources of risks and their management strategies. Crop/livestock/machinery insurance: Weather based crop insurance (WBCIS) and *Pradan Mantri Fasal Bhima Yojana* (PMFBY), their features; Resource economics: Meaning of resource economics difference between NRE and agricultural economics, unique properties of natural resources, positive and negative externalities in agriculture, inefficiency and welfare loss, solutions, management of common property resources of land, water, pasture, fishery and forest resource.

Practical

Basic concepts in production economics and farm management; study and visit to different farm layouts and appraisals of farm resources; Analysis of costs and revenue concepts; Computation of depreciation cost of farm assets; Determination of most profitable level of input use in a farm production process; Determination of least cost combination of inputs; Selection of most profitable enterprise combination; Application of equi-marginal returns/opportunity cost principle in allocation of farm resources; Application of the principle of comparative advantage; Estimation of cost and returns using CACP cost concepts for crop, horticulture and livestock enterprises; Farm inventory analysis; Preparation of optimum farm plan using budgeting technique using partial and complete budgeting; visit to farms to study farm records and accounts; preparation of profit and loss accounts compensation for crop loss; Collection and analysis of data on various resources in India; Practical Examination.

Suggested Readings

1. Chinna, S.S., Agricultural Economics and Indian Agriculture.
2. Heady, E.O. and Dhillon, J.L., Agricultural Production Functions.
3. Jhon, P. Doll and Frank. Orezen, Production Economics: Theory with Applications.
4. Johl, S.S. and Kapoor, T.R., Fundamentals of Farm Business Management.
5. Memoria, C.B., Agricultural Problems of India.
6. Raju, V.T. and Vishwashankar Rao, Economics of Farm Production and Management.
7. Sadhu and Singh, Fundamentals of Agricultural Economics.
8. Sankhyan, P.L., Introduction to Economics of Agricultural Production.
9. Spinger, Natural Resource Management and Policy.
10. Subba Reddy *et al.,* Agricultural Economics.

Marketing of Agricultural Inputs and Outputs 2 (1+1)

Objectives

1. To understand the principles of agricultural marketing, including input and output markets
2. To learn about marketing strategies and techniques for agricultural inputs and products
3. To explore pricing mechanisms, market structures, and distribution channels in the agricultural sector
4. To develop skills to effectively market agricultural inputs and outputs, maximizing profitability for farmers and stakeholders

Theory

Agricultural Marketing- Definition, scope and classification of agricultural marketing.

Agricultural input marketing – meaning and importance; Agricultural Inputs and their types – farm and non-farm, role of cooperative, public and private sectors in agri input marketing. Seed Marketing: Importance, Types of seeds, Demand and supply of seeds; agencies involved in Seed marketing; distribution, export import of seeds; Role of NSC and State Seed Corporation. Government policy on seed marketing. Fertilizer Marketing: Production, export-import, supply of chemical fertilizers. Demand/consumption, regional disparity in consumption, pricing policy; subsidy on fertilizers; marketing system – marketing channels, Agencies involved in fertilizer marketing- Public, Private, Co-operative sectors. Problems in distribution. Plant Protection Chemicals: Production, export/import, consumption, marketing channels. Electricity/Diesel Oil-distribution, pricing of electricity for agriculture use; subsidy on electricity. Farm Machinery and Implement: Production, supply, demand, distribution channels of farm machines; Agencies involved in distribution of agro-machineries and implements. Meaning and importance of Land reforms and tenancy in agriculture, ceiling, elasticity, pricing. Labour markets - productivity, heterogeneity, wage differentials – skill differentials. Credit: importance, types and sources. IT applications in agri- input marketing.

Practical

Input Market Analysis, Primary and Secondary Survey of input use, Exercise on Market Segmentation, Case Study on Product Management, Channel Management in Agri input, Case Study on Brand Management. Designing Communication and Promotion Measures – Seed, Fertilizer, Plant Protection Chemicals, Agricultural Machinery and Implements. Market Research – Seed, Fertilizer, Plant Protection Chemicals, Agricultural Machinery and Implements. Formulation of Marketing Strategy, Report Presentations.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., Agricultural Marketing in India.
2. Agricultural Economics, Kalyani Publications.
3. Ruddra Dutt and Sundharam K.P.M., Indian Economics.

Agricultural Finance and Insurance 2 (1+1)

Objective

1. To understand the principles of agricultural finance, including credit, investment, and risk management.
2. To learn about financial tools and services available to farmers, including loans, grants, and insurance.
3. To explore the role of insurance in mitigating agricultural risks such as crop failure, weather events, and market fluctuations.
4. To develop skills to analyze financial statements, assess investment opportunities, and make informed financial decisions in agriculture.

Theory

Agricultural Finance – meaning, definition, nature and scope. Agricultural Credit - meaning, definition, importance and classification based on various criteria.

Credit Analysis - 3 Rs of Credit; 5 Cs of Credit; and 7 Ps of Credit; Repayment Plans. Financial Statements – meaning, types and uses. Time Value of Money / Principle of Time Comparison – meaning and importance. Compounding and Discounting.

History of financing agriculture in India. Nationalization of banks – meaning and objectives; Village Adoption Scheme – origin and objectives; Lead Bank Scheme – origin and functions; Regional Rural Banks – origin, objectives and features; Micro-financial Institutions: meaning and features; Self Help Groups (SHGs) – meaning and features.

Scale of finance and security for loans. Banking schemes for agricultural finance - Differential Rate of Interest (DIR) Scheme – origin and features; Kisan Credit Card Scheme – origin, objectives and features. Financial inclusion – *Jan Dhan Yojana*, financial literacy and business correspondent model. NPAs in agricultural lending: applicability of the SARFESI Act in agricultural lending.

Financing Agencies: RBI – activities and functions; NABARD – genesis, objectives and functions; AFC – functions; ADB and World Bank – origin and functions; IMF, IFC and IDA. Deposit Insurance and Credit Guarantee Corporation of India (DICGC) – Origin and functions.

e-Payment systems - The Banking Ombudsman Scheme-Non-Banking Financial Institutions (NBFI) – meaning and structure, types of activities of NBFIs -Merchant banking in India - Functions - Mutual Funds – Features and structure - Credit rating agencies in India, Process - Factoring mechanism - Forfeiting services.

Insurance – meaning and definition. Crop Insurance Scheme – origin, meaning, importance and advantages of crop insurance, Comprehensive Crop Insurance Scheme (CCIS), National Agricultural Insurance Scheme (NAIS), Modified National Agricultural Insurance Scheme (MNAIS), and Weather based Crop Insurance and *Fasal Bhima Yojana* and Unified Package Insurance Scheme (UPIS). Assessment of crop losses, determination of compensation, limitations in application and estimation of crop yields. Livestock insurance – origin, meaning and importance.

Practical

Exercises on time value of money - compounding and discounting. Estimation of credit needs for crop and livestock enterprises. Determination of scale of finance for farm enterprises. Repayment plans for short-term loans and term loans. Estimation of risk in crop and livestock enterprises. Estimation of premium amount for insurance. Visits to financial inclusion branch of commercial bank and regional rural bank; and insurance agency in public and private sectors. Visit to weather station.

Suggested Readings

1. Agarwal, R.N., 1996, Financial Liberalization in India- A study of Banking System and Stock markets.
2. Bagchi, A.K., 1987, The Evolution of the State Bank of India (Part I and II).
3. Bhasin, Niti, 2007, Banking and Financial Markets in India 1947 to 2007.

4. Desai, D.K. and Tambad, S.B., 1973, Farm Finance by a Commercial Bank.
5. Gulati, Ashok and Seema, Bathla, 2002, Institutional Credit to Indian Agriculture: Defaults and Policy Options. NABARD Occasional Paper- 23.
6. Karthykeyan, T.K., 1990, Long-term Financing of Agriculture Land Development Banks in a Multi-Agency System.
7. Mathur, B.L., 1989, Indian Banking- Performance, Problems and Challenges.
8. Mishra, R.K., 2005, Banking Sector Reforms and Agricultural Finance.
9. Murray, William, G., 1947, Agricultural Finance- Principles and Practices of Farm Credit.
10. Nakkiran, S., 1980, Agricultural Financing and Rural Banking in India- An evaluation.
11. Pandey, U.K., 1990, An Introduction to Agricultural Finance.
12. Subba Reddy, S. and Raghuram P., 2005, Agricultural Finance and Management.

Introduction to Genetics and Plant Breeding 2 (1+1)

Objectives

1. To understand the principles of genetics and their application in plant breeding
2. To learn about breeding techniques used to improve crop traits such as yield, disease resistance, and quality
3. To explore the importance of genetic diversity and its role in crop improvement and adaptation to changing environments
4. To develop skills to evaluate and select superior plant genotypes for breeding programs aimed at enhancing agricultural productivity and sustainability

Theory

History of Genetics and Plant Breeding, Study of Chromosome- Structure, functions, cell division. Mendel's laws of inheritance, Mode of inheritance- monogenic, polygenic, cytoplasmic. Modes of reproduction in plants: sexual and asexual, differences between self- and cross-pollinated crops. Male sterility and their significance in plant breeding. Breeding for self-pollinated (Mass, pure line, pedigree and bulk methods), cross-pollinated (Ear to row, Backcross, Development of synthetics, composites and hybrids), vegetatively propagated crops (Clonal selection).

Practical

Mendelian ratios- Problems related to segregation and independent assortment and polygenic inheritance. Study of linkage, crossing over percentage, map distance. Study of floral structure and biology of important cereals, pulses, oilseeds and commercial crops. Study of plant breeder's kits, selfing and crossing techniques. Male sterility: A, B and R lines and their utility. Pollen fertility study and its importance. Layout of field experiments, principles, data recording and elementary statistics and analysis of data. Visit to different crop breeding schemes.

Suggested Readings

1. An Introduction to Genetic Analysis by Suzuki *et al.*
2. Breeding Field Crops by JM Poehlman.
3. Genetics by Strickberger.

4. Plant Breeding: Principles and Practices by JR Sharma.
5. Principles of Plant Breeding (1st and 2nd Edition) by RW Allard.

Principles and Practices of Seed Science and Technology 2 (1+1)

Objectives

1. To understand the principles of seed science, including seed development, physiology, and quality
2. To learn about seed processing, storage, and testing techniques used to maintain seed viability and vigour
3. To explore the role of seed technology in ensuring the availability of high-quality seeds for sustainable crop production
4. To develop skills to manage seed resources effectively, ensuring the successful establishment and productivity of crops

Theory

Introduction: Importance of improved seed in Indian Agriculture, quality seeds and its characteristics. History: Development of seed industry in India. Seed Program: Types of seed program, development of seed program, basic strategy for organizing seed production, different classes of seeds, generation system of seed multiplication, seed replacement rate (SRR), varietal replacement rate (VRR), agencies involved in seed program. Principles of seed production: Factors affecting genetic purity and varietal deterioration, methods / safeguards to maintain genetic purity during seed production, study of improved production practices for higher seed yield and quality. Economic principles: Study of SMR, importance of SMR, SMR in different crops. Hybrid seed production: Requirements of hybrid seed production, methods of hybrid seed production and types of hybrids. Varietal and hybrid seed production (Foundation and Certified seed classes) in maize, rice, sorghum, bajra, sunflower, red gram, cotton, castor, chilli, tomato and okra. Varietal seed production in wheat, soybean, chickpea, black gram. Seed processing and packaging: Seed processing-its importance and methods seed packaging and seed branding. Seed testing: Seed testing procedures in different crops, minimum seed standards for certification. Seed storage, different types of storage conditions. Seed legislation: Seeds Act 1966, Seed Rules 1968, Seed (Control) order 1983, New policy on seed development 1988, PPVFRA 2001, Seeds Bill 2004, OECD Seed certification and its importance. Seed marketing: Seed demand forecasting, factor affecting seed marketing, seed supply systems, sale promotional activities for seed marketing, seed marketing organizational structures. International seed trade, developing seed entrepreneurship. Importance of account keeping in seed business. Cost estimation and pricing of seed.

Practical

Identification of seeds of field and horticultural crops, study of seed structure in monocot and dicot seeds. Study of floral biology of important self, cross and often cross pollinated agriculture and horticulture crops. Working of SRR, VRR and SMR Types of isolation, determination of isolation distance, requirements, study of isolation requirements in different crops for foundation and certified seeds. Study of hand emasculation, hand pollination and detasseling techniques. Study of distinguishing morphological characters in varieties and parents of hybrids. Study of synchronization

techniques for hybrid seed production, planting ratio. Supplementary pollination techniques, border rows for hybrids seed production. Study of seed cleaning and grading technique, and equipment. Seed packing and seed treatment techniques. Practicing seed testing in different crops seeds. Vigour tests in different crop seed lots. Studying of safe seed storage techniques. Working out cost of seed production, seed pricing. Account keeping books. Visit to seed production plots of public and private sector companies. Visit to seed production organization to understand account keeping and working of seed prices in seed business.

Suggested readings

1. Agarwal, P.K. and M., Dadlani, 1987, Techniques in Seed Science and Technology. South Asian Publishers, New Delhi.
2. Agarwal, V.K., 2003, Seed Health. International Book Distributing Co.
3. Agrawal, R.L., 1996, Seed Technology. Oxford and IBH Publicity Company, New Delhi.
4. Bhale, M.S., 2013, A Handbook of Seed Certification. Vardhman Books and Periodicals.
5. Joshi, A.K. and Singh, B.D., 2003. Seed Science and Technology. Kalyani Publishers. Ludhiana.
6. Khare, D.P., 1994. Stored Grain Pests and their Management. Kalyani Publishers. Ludhiana.
7. Kulkarni, G.N., 2002, Principles of Seed Technology. Kalyani Publishers. Ludhiana.
8. Nema, N.P., 1986, Principles of Seed Certification and Seed Testing. Pub. Allied Publishers Private limited, New Delhi.
9. Paul, Neergaard, 1977, Seed Pathology, Vol. - I and II. McMillan Press, London.
10. Sen, Subip and Ghosh, Nabinanda, 2002. Seed Science and Technology. Kalyani Publishers. Ludhiana.
11. Singhal, N.C., 2002. Hybrid Seed Production. Kalyani Publishers, Ludhiana.
12. Tunwar, N.S. and Singh, S.V., 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, New Delhi.

Livestock, Poultry and Fish Production Management 2 (1+1)

Objectives

1. To understand the principles of livestock, poultry, and fish production management
2. To learn about breeding, nutrition, health, and housing practices for optimizing animal productivity and welfare
3. To explore sustainable management strategies to improve efficiency, profitability, and environmental sustainability in animal production systems
4. To develop skills to address challenges related to disease prevention, feed efficiency, and market demands in livestock, poultry, and fish production

Theory

Role of livestock, poultry and fisheries in the national economy. Classification of breeds of cattle, buffalo, sheep, goat and poultry. Principles of housing system for different species of livestock and poultry. Classification of feeds and fodder for livestock and poultry. Preparation of concentrate mixture. Conservation and enrichment of fodder. Signs of Estrus. Artificial insemination and its importance Feeding and management of calves, heifers, pregnant, milch animals and bullocks

Brooding management in poultry. Management of broilers, growers, layers and backyard birds. Management of sheep and goats. Prevention and control of important diseases of livestock and poultry. Marketing and economics of livestock and poultry. Introduction to fish and fisheries in India. Fisheries resources of India and importance of inland aquaculture. Important cultivable fishes and their production

Practical

Introduction to University Livestock Farms and Common Terminologies of Animal Sciences. Study of external body parts of livestock. Study of different breeds of Indian and Exotic Livestock. Study of housing for Livestock. Estimation of age of animals. Methods of identification of animals. Judging and culling of animals and poultry. Physical and chemical properties of milk, Clean milk production. Estimation of specific gravity of milk. Estimation of fat of milk. Estimation of total solids and SNF of milk. Detection of milk adulterants and Preservatives. Egg structure, chemical composition and grading. Study of common feeds and fodder. Conservation of Fodder and computation of ration for livestock. Common equipment used in livestock farms. Economics of Livestock Units. Visit to aquaculture and seed production fish ponds.

Suggested Readings

1. Banarjee, D.C., Textbook of Animal Husbandry.
2. Felix, S., T.V. Anna Mercy and S.K. Sawain, Ornamental Aquaculture Technology and Trade in India.
3. Handbook of Animal Husbandry, ICAR.
4. Jadhav, N.V. and M.F. Siddiqui, Handbook of Poultry Production and Management.
5. Jagadish, Prasad, Animal Husbandry and Dairy Science.
6. Jagadish, Prasad, Principles and Practices of Dairy Farm Management.
7. Jagadish, Prasad, Sheep, Goat and Swine Production.
8. Jagadish, Prasad, Poultry and Rabbit Production.
9. Shreenivashaiah, P.V., Scientific Poultry Production.
10. Sastry, N.S.R. and C.K., Thomas, Livestock Production Management.
11. Satiyadas, R., Narayankumar, R., and Aswathy, N., Marine Fish Marketing in India.
12. Srivastava, U.K., Inland Fish Marketing in India.
13. Sukumar, De, Outline of Dairy Technology.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art-skill and expertise on management of disasters.

Theory

Introduction to environment; environmental studies. Definition, scope and importance, multidisciplinary nature of environmental studies. Segments of environment, spheres of earth;

lithosphere, hydrosphere, atmosphere. Different layers of atmosphere. Natural resources; classification. Forest resources. Water resources. Mineral resources. Food resources. Energy resources. Land resources. Soil resources. Ecosystems. Concept of an ecosystem; structure and function of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and value of biodiversity. Biodiversity hot spots. Threats and conservation of biodiversity.

Environmental pollution. Definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, light pollution. Solid waste management; classification of solid wastes and management methods, composting, incineration, pyrolysis, biogas production, causes, effects and control measures of urban and industrial wastes. Social issues and the environment. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics; issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection act. Air (prevention and control of pollution) act. Water (prevention and control of pollution) act. Wildlife Protection Act. Forest Conservation act. Human population and the environment; environment and human health. Human rights, value education. Women and child welfare. Role of information technology in environment and human health.

Disaster management; disaster definition, types, natural disasters, floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made disasters, nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and national strategy for disaster reduction. Concept of disaster management, national disaster management framework, financial arrangements, role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control. Armed forces in disaster response. Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets (river/forest/grassland/hill/mountain). Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De A.K., 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti P.G., 2011. Disaster management - India's Risk Management Policy Frameworks and Key Challenges. Published by Centre for Social Markets (India), Bengaluru. 36 pp.
3. Erach Bharucha. Textbook for Environmental Studies. University Grants Commission, New Delhi.

4. Parthiban K.T., Vennila S., Prasanthrajan M., Umesh Kanna S. 2003. Forest, Environment, Biodiversity and Sustainable Development. Narendra Publishing House, New Delhi (In Press).
5. Prasanthrajan M, P.P. Mahendran., 2008. A textbook on Ecology and Environmental Science. Agrotech Publishing Academy, Udaipur. ISBN 81-8321-104-6. First Edition: 2008.
6. Prasanthrajan M, 2018. Objective Environmental Studies and Disaster Management. Scientific Publishers, Jodhpur, India. ISBN 9789387893825. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment. Rastogi Publications, Meerut, India.
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage Learning Publication, Belmont, USA.

National Cadet Corps II (NCC-II) **1 (0+1)**

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical

Arms Drill - Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa. Guard mounting, guard of honour, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme II (NSS-II) **1 (0+1)**

Objective

- To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical

- Importance and role of youth leadership: Meaning, types and traits of leadership, qualities of good leaders, importance and roles of youth leadership
- Life competencies: Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication
- Youth development programs: Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation: Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- Youth and yoga: History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Personality Development 2 (1+1)

Objective

- To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B behaviours, Personality and organizational behaviour.

Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception, Attribution theory and case studies on perception and attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behaviour, Learning and training, Learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation - theories and principles, teamwork and group dynamics.

Practical

MBTI personality analysis, Learning styles and strategies, Motivational needs, Firo-B, Interpersonal communication, Teamwork and team building, Group dynamics, Win-win game, Conflict management, Leadership styles, Case studies on personality and organizational behaviour.

Suggested Readings

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.

2. Heller, Robert, 2002, Effective Leadership. Essential Manager Series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager Series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R., 2009, Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

SEC-3: Seed Production and Seed Testing **2 (0+2)**

Objectives

1. To understand the principles and techniques of seed production for various crops
2. To learn about seed testing methods to ensure seed quality and viability
3. To explore the regulations and standards governing seed production and testing
4. To develop skills to manage seed production processes effectively, from planting to harvesting and testing, to ensure the availability of high-quality seeds for farmers

Practical

Book keeping of records and accounts of Seed Production. Assessment of market demand and selection of varieties/ hybrids including their parents of the chosen crops grown in the region. Acquaintance of seed classes, seed sources, labels, purchase norms, field and seed standards, quality tests required under certification scheme. Planning and layout of seed production plot under field conditions. Application and amplication of land and isolation requirements as per certification standards. Preparation of land and application of manures and fertilizers, etc. Preparation and raising of nursery beds/seedling raising in polythene bags, etc. Acquaintance of different methods of sowing / transplanting - use of pre-sowing seed treatments-growth regulators/chemicals / rhizobium /other microbial inoculants, etc. Application of planting ratios and border rows and marking of parental rows, Block method of planting in hybrid seed production plot. Application of staggered sowings and manipulation of fertilizers/ growth regulators/micronutrients, etc. on synchrony of parental flowering in hybrid seed production. Application of cultural and nutrient managements for control of physiological shredding of floral buds/fruits/ pods, etc. Timely management of after care operations at various growth stages. Diagnostic identification and management of pest and disease attacks at various growth stages. Diagnostic identification and characterization of A, B, R lines in hybrids of different crops viz. sorghum / sunflower / bajra / red gram / okra / chilli, etc. and their maintenance. Carrying out detasseling operation in maize hybrid seed production. Carrying out hand emasculation and hand pollination operations in hybrid seed production of cotton /tomato /brinjal /chilli /okra, etc. Application of supplementary pollination methods at flowering time to enhance hybrid seed setting and yield, Provision of honey bee colonies, etc. in sunflower, etc.-Observations on seed setting on female parental line. Acquaintance and application of roguing index based on diagnostic morphological characters at pre- and post-harvest stages. Acquaintance of different methods of conducting field inspections by taking field counts to conform to prescribed field standards at different growth stages.

Acquaintance of manual apical bud pinching in okra - nipping of vegetative branches of female plants after crossing period in cotton, etc. Determination of physiological maturity and application of different methods of harvesting/ picking in varietal and hybrid seed production. Acquaintance of manual method of sorting and grading in cobs /pods /fruits, etc as per minimum certification standards and procedures. Acquaintance of different methods of shelling /seed ginning / seed extraction and recovery, etc. Management of different methods of threshing/ drying/ processing/ treating/ packaging/ labeling/ sealing/ storing, etc., as per minimum certification standards and procedures. Acquaintance of working designs of threshers, cleaners, driers, processing and packaging machineries, etc. Management of storage pests by different seed treatment methods – fungicides/ insecticides/ botanicals, etc.

Management of seed store sanitation. Visit to farmer's seed production plots undertaken by NSC /KSSC / Private Sector Seed Companies/ UAS Seed Unit, etc. Visit to UAS Seed plots /ARS Farms / Crop schemes/ Poly houses/ High tech Hort., etc. Visit to GOT farms of KSSC /KSSCA/ Seed Unit, etc. Visit to NSC /KSSC/KSSCA/ Seed Dealer, etc. Visit to Seed Processing Units/ Seed Testing Laboratory /Seed ware houses/ Cold storage units, etc.

Estimation of cost and returns/ Economics of Seed Production /cost benefit ratio. Estimation of Investment Capital requirements and operational costs. Preparation of Balance Sheet Income and Cash flow statements. Market Survey for estimation of demand and sources of supply. Identification of market channels and the estimation marketing costs and margins. Report writing and submission, Examination.

Suggested Readings

1. Agarwal, P.K. and M. Dadlani, 1987, Techniques in Seed Science and Technology, South Asian Publishers, New Delhi.
2. Agrawal, R.L., 1996, Seed Technology, Oxford and IBH Publicity Company, New Delhi.
3. Agarwal, V.K., 2003, Seed Health, International Book Distributing Co.
4. Bhale, M.S., 2013, A handbook of Seed Certification, Vardhman Books and Periodicals.
5. Joshi, A.K. and Singh, B.D., 2003, Seed Science and Technology, Kalyani Publishers, Ludhiana.
6. Khare, D.P., 1994, Stored Grain Pests and their Management, Kalyani Publishers, Ludhiana.
7. Kulkarni, G.N., 2002, Principles of Seed Technology, Kalyani Publishers, Ludhiana.
8. Nema, N.P., 1986, Principles of Seed Certification and Seed Testing, Allied Publishers Private limited, New Delhi.
9. Paul Neergaard, 1977, Seed Pathology, Vol.-I and II, McMillan Press, London.
10. Sen Subip and Ghosh Nabinanda, 2002, Seed Science and Technology, Kalyani Publishers, Ludhiana.
11. Singhal, N.C., 2002, Hybrid Seed Production, Kalyani Publishers, Ludhiana.
12. Tunwar, N.S., and Singh, S.V., 1988, Indian Minimum Seed Certification Standards. Central Seed Certification Board, New Delhi.

SEC-4: Livestock Production and Management 2 (0+2)

Objectives

1. To understand the principles of livestock production, including breeding, nutrition, and health management.
2. To learn about efficient management practices to optimize animal welfare, productivity, and profitability.
3. To explore sustainable livestock production systems to minimize environmental impact and ensure long-term viability.
4. To develop skills to address challenges such as disease control, feed management and breeding strategies in livestock farming.

Practical

Orientation. Maintenance of 10 dairy animals (5 cattle and 5 buffaloes). Routine management practices such as cleaning, grooming, colostrum feeding, deworming, vaccination schedule, dehorning/disbudding; methods of identification; dentition; selection and culling of livestock; Record maintenance; assisting during calving; care of pregnant animals. Clean Milk Production: Milking, Different milking methods, Machine milking, Milk packaging. Feeding management; Feeding of calves, heifers, lactating dairy cows and buffaloes, and bulls. Preparation of concentrate mixture, maintenance of equipment required for feed mixing; Feed ingredients; Fodder production: Preserving fodder: Silage preparation: Dry fodder enrichment; Azolla Production; Hydroponics; Feed additives. Use of different farm equipment and their maintenance, e.g., Chaff Cutter, milking machine. Identification of animals in heat and presenting for artificial insemination. Farm waste Management; composting; vermicomposting; biogas production. Sheep and Goat Rearing. Routine management practices for rearing of sheep and goat: cleaning of sheds, watering, feeding, preparation of feed supplements, Deworming, monitoring growth by measurements of regular body parts and weights. Laboratory analysis of milk for quality, feed and fodder samples. Economics of dairy and Sheep/goat farming. Maintaining the register for income and expenditure on the animals allotted to work out the economics. Health Management of Livestock; First Aid.

Suggested Readings

1. Banarjee, D.C., Textbook of Animal Husbandry. Kalyani Publishers, New Delhi.
2. De, Sukumar, Outline of Dairy Technology. Kalyani Publishers, New Delhi.
3. ICAR. Handbook of Animal Husbandry. ICAR.
4. Jadhav N.V. and Siddiqui M.F. Handbook of Poultry Production and Management. Kalyani Publishers, New Delhi.
5. Prasad Jagadish, Animal Husbandry and Dairy Science. Kalyani Publishers, New Delhi.
6. Prasad Jagadish, Poultry and Rabbit Production. Kalyani Publishers, New Delhi.
7. Prasad Jagadish, Sheep, Goat and Swine Production. Kalyani Publishers, New Delhi.
8. Prasad, Jagadish, Principles and Practices of Dairy Farm Management. Kalyani Publishers, New Delhi.
9. Sastry, N.S.R. and Thomas, C.K., Livestock Production Management. Kalyani Publishers, New Delhi.
10. Shreenivashaiah P.V., Scientific Poultry Production. IBH.

Semester III

Food Business Management 2 (2+0)

Objectives

1. Understand the principles of food business management, including production, distribution, and marketing
2. Learn about food safety regulations, quality control, and supply chain management
3. Explore strategies for developing and launching food products, managing operations, and meeting consumer demands
4. Develop skills to analyze market trends, develop business plans, and manage resources effectively in the food industry

Theory

Introduction to food, food business and food business management, Types and classification of Foods, Food Business, Institutions involved in Food preparation, Marketing and Exporting. Present status of food industry in India – Current market size and future potential – Key drivers for growth. Recent advances in food processing, Quality management in food industry- Food Safety and standards (ISO and Codex). Food quality certification- AFS, BRC, HACCP, BFSI. Food traceability. Food preservation methods - Food Packaging and Labelling - Improved food grain storage structures. Logistics management at different stages of marketing the food products. Food business environment and policy. IPR in Food Industry, Entrepreneurship opportunities in food business. Food Economics and Policy, Innovation in food business at domestic and international, Food Business Marketing. Successful business organizations. Food business Environment and Policy, Government, Regulations/Guidelines for food sector. Food Waste management. Food Retailing, Formats of Food Service Industry, Policies related to Food Processing and Markets, Institutions enabling food processing sector, Food Safety and Standards Authority of India.

Suggested Reading

1. Mahtab. S, (1996) Textbook of Human Nutrition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Srilakshmi. B, (2006) Food Science, New Age International (Ltd) Publishers, New Delhi.
3. Srilakshmi. B, (2007) Nutrition Science, New Age International (Ltd) Publishers, New Delhi.
4. Swaminathan. M, (1997) An advanced textbook on Food and Nutrition, Volume I, The Bengaluru Printing and Publishing Co. Ltd., Bengaluru.
5. Swaminathan. M, (1997) An advanced textbook on Food and Nutrition, Volume II, The Bengaluru Printing and Publishing Co. Ltd., Bengaluru.

Value Chain and Retail Management in Agribusiness 2 (1+1)

Objectives

1. Understand the dynamics of value chains in agribusiness, from production to retail
2. Learn about supply chain management, distribution, and logistics in agricultural products

3. Explore retail management strategies, including branding, marketing, and customer relationship management
4. Develop skills to optimize value chain efficiency, reduce costs, and meet consumer preferences in agribusiness retail

Theory

Meaning of value and value chain. Concept of value chain. Difference between supply chain and value chain. Components of value chain. Value chain governance. Value chain methodology. Economics of value chain. Financing of agricultural chain. Market linkages in value chain. Mapping of value chain. Potters value chain. Introduction to Retail Management. Retailing in India. Types of retailers. Retail formats. Online and offline retailing. Organised and unorganized retailing. Retail location and layout. Retail strategies. Store management. Merchandise and inventory management. Retail marketing mix, role of IT in retail management. E-tailing.

Practical

Presentation and Discussion on above topics. Visit to retail formats. Visits to processing units. Visit to logistics, godowns, warehouses etc.

Suggested Readings

- Retail Supply Chain Management: Quantitative Models and Empirical Studies (International Series in Operations Research and Management Science, 122). Softcover reprint of hardcover 1st ed. 2009 Edition by Narendra Agrawal (Editor), Stephen A. Smith (Editor).
- Retail Supply Chain Management. Hardcover – 5 October 2017. James B. Ayers (Author) and Mary Ann Odegaard (Author).
- The Retail Value Chain: How to Gain Competitive Advantage through Efficient Consumer Response (ECR) Strategies. Sami Finne, Hanna Sivonen. Kogan Page Publishers, 03-Dec-2008 - Business and Economics - 384 pages.

Introduction to Accountancy 3 (2+1)

Objectives

1. Understand the basic principles and concepts of accounting
2. Learn the fundamentals of financial statements preparation and analysis
3. Explore the role of accounting in business decision-making and financial management
4. Develop skills to record, classify, and interpret financial transactions accurately and effectively

Theory

Introduction to accountancy: Meaning and importance of accounting. Meaning and definition of book keeping. Accountancy objectives of book keeping: branches of accounting. Accounting cycle. Generally Accepted Accounting Principles (GAAP)-concepts and conventions. System of book keeping: Single entry and Double entry system of keeping, Classification of accounts. Golden rules of accounting; Books of accounts: Journal and Ledger –journalizing, ledger posting, and preparation of ledger accounts. Subsidiary books-Kinds of subsidiary books- Day books: purchase book, sales book, returns book, Bill books, journal proper, Cash books - nature and objectives of cash book,

types of cash book, petty cash book; Bank reconciliation statement; Preparation of Trial balance-Methods of trial balance; Final accounts - Trading account, Profit and loss account and Balance sheet; Single entry system of accounts - preparation of statement of affairs, profit or loss statement, advantages and disadvantages. Non-trading organizations. Preparation of accounts relating to non-trading organization. Concepts of revenue and capital expenditure and income, Receipts and payment account, Income and expenditure account, and Balance sheet.

Practical

Preparation of journal and recording the business transactions in journal, Preparation of ledger and ledger posting, Preparation and solving of problems relating to subsidiary books, Preparation of cash book with single column, Preparation of cash book with double column, Preparation of cash book with triple column and contra entries, Preparation petty cash book in imprest system, Preparation of bank reconciliation statement, Preparation of trial balance, Preparation of final accounts- trading, profit and loss accounts and balance sheet, Preparation of profit and loss account and balance sheet under single entry system. Preparation of non-trading accounts receipts and payment accounts. Preparation of non-trading accounts -income and expenditure accounts and balance sheet.

Suggested Readings

- Jain, S.P., Advanced Accountancy.
- Kadakol, M.B., Accountancy for PUC-I and II.
- Raman, B.S., Accountancy.

Soil and Water Management 2 (1+1)

Objectives

1. Understand the principles of soil and water management in agriculture
2. Develop skills to sustainably manage soil and water resources to enhance agricultural productivity and environmental sustainability

Theory

Concept of soil, meaning and definition; soil components and important soil physical (soil texture, structure density, porosity, soil water; soil air, soil temperature and soil colour) and chemical (pH, EC, CEC and base saturation) properties in brief, Organic matter, Land capability classification and suitability. Soils of India and respective state, Soil quality and soil health, Distribution of waste land/degraded lands and problem soils in India, problems associated and management of salt affected soils, calcareous soils, acid soils, acid sulphate soils, eroded and compacted soils, flooded / water logged soils, physically constrained soils, polluted soils. Alternate land use strategies for management of problematic soils including bioremediation/phytoremidation. Irrigation water-quality and standards, utilization of poor quality water in agriculture.

Practical

Soil sample collection and it's preparation for analysis. Determination of soil colour, density, porosity and moisture content. Determination of soil texture by feel method. Determination of

infiltration rate. Determination of aggregate stability. Determination of soil reaction (pH) and total soluble salts content (EC) in soil. Determination of organic matter in soil. Determination of lime requirement of acid soils. Determination of water soluble cations. Determination of water soluble anions. Determination of exchangeable cations (Ca, Mg, Na and K) and computation of ESP. Determination of gypsum requirement of sodic soils. Determination of quality of irrigation water (pH, EC, SAR, RSC, boron, chlorides etc.)

Suggested Readings

1. Brady Nyle C and Ray R Well, 2014. Nature and Properties of Soils. Pearson Education Inc., New Delhi.
2. Indian Society of Soil Science, 2002. Fundamentals of Soil Science. IARI, New Delhi.
3. Thiyageshwari, S., M.V. Sriramachandrasekharan and D. Selvi., 2015. Fundamentals of Soil Inventory, Problem Soils and Irrigation water. Jaya Publishing House, New Delhi (ISBN: 978-9384337-438).

General Horticulture 2 (1+1)

Objectives

1. Understand the basic principles of horticulture, including plant biology, propagation, and cultivation
2. Learn about the cultivation techniques and management practices for various horticultural crops
3. Explore the importance of pest and disease management, as well as environmental factors affecting horticultural production
4. Develop skills to apply horticultural knowledge in the production of fruits, vegetables, ornamental plants, and herbs for both commercial and personal use

Theory

Horticulture- Definition, branches, importance and scope. Methods of plant propagation - sexual and asexual. General principles and practices of cultivation of important fruits-mango, banana, citrus, grape, guava, sapota. Importance of vegetables, kitchen garden, etc. General principles and practices involved in cultivation of important vegetables solanaceous crops, cole crops, cucurbits, peas and beans. Importance of floriculture and different components of ornamental garden and cultivation of important flower crops. Medicinal and aromatic plants: active principle, medicinal properties and aromatic principles.

Practical

Visit to orchards and gardens; Plant propagation methods; Study of varieties, cultural practices, plant protection of important fruits; Study of varieties, cultural practices, plant protection of important vegetables; Study of culture of medicinal plants; Study of culture of aromatic plants; Study of different components of ornamental garden - annuals, shrubs, trees, climbers, hedges and edges; Study of culture of flower crops.

Suggested Readings

1. ICAR. 2002. Handbook of Horticulture. ICAR.
2. Peter KV. 2008. (Ed.) Basics of Horticulture. New India Publ. Agency.
3. Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2008. Management of Horticultural Crops. New India Publ. Agency.
4. Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency.

Protected Cultivation and Secondary Agriculture 2 (1+1)

Objectives

1. Understand the principles and techniques of protected cultivation, such as greenhouse and polyhouse farming
2. Learn about secondary agriculture practices like value addition, processing, and post-harvest management
3. Explore methods to optimize production, quality, and profitability in controlled environments
4. Develop skills to integrate protected cultivation and secondary agriculture techniques to enhance yield, quality, and market value of agricultural products

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in green houses, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero and hydrodynamic properties of cereals, pulses and oilseeds. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of greenhouse equipments. Visit to various Post-Harvest Laboratories. Determination of Moisture content of various grains by oven drying and infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Suggested Readings

1. Green house technology - Aruprathan Ghosh, Kalyani Publishers, New Delhi.
2. Green House Technology and Management - K. Radha Manohar and C. Igathinathane, BS Publications, Gujarathi Galli, Sultan Bazar, Koti, Hyderabad, A.P.

3. Greenhouse Management for Horticultural Crops - S. Prasad and U. Kumar, Agrobios, Agro house, Jodhpur.
4. Principles and Practices of PostHarvest Technology - P. H. Pandey, Kalyani Publishing, Ludhiana.
5. Unit Operations of Agricultural Processing - K. M. Sahay and K.K. Singh, Vikas Publishing House Pvt Limited, New Delhi.

Agricultural Marketing and Trade **3 (2+1)**

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- NAFED, TRIFED, NCDC, APEDA, CWC, SWC, FCI, CACP, DMI, Commodity Corporations and Boards – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of

marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Publishers, New Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R.K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Physical Education, First Aid, Yoga Practice and Meditaion 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education. Training and Coaching, meaning and concept. Methods of training; aerobic and aerobic exercises. Calisthenics, weight training, circuit training, interval training, Fartlek training. Effects of exercise on muscular, respiratory, circulatory and digestive systems. Balanced diet and nutrition; effects of diet on performance. Physiological changes due to ageing and role of regular exercise on ageing process. Personality, its dimensions and types. Role of sports in personality development. Motivation and achievements in sports. Learning and theories of learning. Adolescent problems and its management. Posture, postural deformities. Exercises for good posture.

Yoga; history of yoga, types of yoga, introduction to yoga. Asanas, definition and importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan,

Sarpasan, Ardhdhanurasan, Sawasan. Suryanamaskar, Pranayama (Definition and Importance), Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari. Meditation, definition and importance, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh. Mudras, definition and importance, Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. Teaching of asanas, demonstration, practice, correction and practice.

History of sports and ancient games. Governance of sports in India. Important national sporting events. Awards in sports. History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First aid equipment and upkeep. First aid techniques. First aid related with respiratory system. First aid related with heart, blood and circulation. First aid related with wounds and injuries. First aid related with bones, joints, muscle related injuries. First aid related with nervous system and unconsciousness. First aid related with gastrointestinal tract. First aid related with skin, burns. First aid related with poisoning. First aid related with bites and stings. First aid related with sense organs. Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Suggested Readings

1. Anatomy of Hatha Yoga by David H. Coulter: This book delves into the anatomical aspects of yoga practice, helping students understand the physiological effects of various yoga poses and sequences.
2. Essentials of Athletic Injury Management by William E. Prentice: This textbook covers the basics of sports injuries, their prevention, assessment, and management, including first aid techniques.
3. First Aid, CPR, and AED by American Red Cross: This manual provides comprehensive guidance on first aid procedures, cardiopulmonary resuscitation (CPR), and automated external defibrillator (AED) use.
4. Physical Education for Lifelong Fitness: The Physical Best Teacher's Guide by SHAPE America - Society of Health and Physical Educators: This resource provides lesson plans, assessment tools, and strategies for teaching physical education with a focus on lifelong fitness.
5. Teaching Yoga: Essential Foundations and Techniques by Mark Stephens: For instructors, this book offers insights into teaching yoga effectively, including sequencing, cueing, and adjusting postures.

SEC-5: Poultry Production Technology 2 (0+2)

Objectives

1. Understand the principles of poultry production, including breed selection, nutrition, and housing
2. Learn about disease prevention, biosecurity measures, and vaccination protocols in poultry farming

3. Explore efficient management practices to optimize growth, egg production, and overall flock health
4. Develop skills to address challenges such as market fluctuations, welfare concerns, and environmental sustainability in poultry production

Practical

Orientation. Rearing of backyard poultry chicks (local and Improved e.g., Giriraja). Setting and management of broiler poultry farm. Management of poultry for egg production (layers). Brooding and Management of Chicks; Setting up of brooder house, handling of chicks, vaccination. Feeding and Watering and lighting management. Management of Poultry birds; light management, vaccination, debeaking, feeding and watering. Egg collection and storage. Quality egg production. Factors affecting egg quality. Assessment of egg quality. Preparation of poultry feed. Factors affecting feed quality. Storage of feed ingredients. Record Maintenance. Management of farm equipment. Farm waste management; composting; vermicomposting; biogas production Economic analysis of poultry production. Maintaining the register for income and expenditure on the animals allotted to work out the economics. First Aid and flock health management.

Suggested Readings

1. Forrest, J.C., Aberle E.D., Harlod B.H., Max D.J., Robert A.M. (1975). Principles of Meat Science, W.H. Freeman and Company, San Francisco.
2. Sharma B.D. (2005). Meat and Meat Production Technology (including poultry production technology). Jaypee Brothers Medical Publishers (Pvt.) Ltd., New Delhi.

Semester IV

Business Laws and Ethics 2 (2+0)

Objectives

1. Understand the legal framework governing business operations and transactions
2. Learn about ethical principles and practices in business decision-making and conduct
3. Explore the implications of business laws and ethics on organizational behaviour, corporate governance, and social responsibility
4. Develop skills to navigate legal and ethical challenges, ensuring compliance and fostering trust in business relationships

Theory

Introduction to Indian legal system: Legislative Powers of the States and the Union. Scope and importance of Business laws. Contracts – meaning, significance, types and essentials of a valid contract. The Indian Contract Act-1872. The Indian Partnership Act, 1932 - General Nature, Registration of Partnership, Partnership Deed, Types of Partners, Rights and Duties of Partners. The Companies Act, 1956 and 2013 - General Nature, types of companies, incorporation of a Company, Memorandum of Association and Articles of Association, management of a company. Provisions of important Acts enacted over time related to business environment: Industries (Regulation and Development) Act, 1951; Income tax Act, 1961. Central Excise Act, 1944; Foreign Exchange Regulation Act (FERA), 1973; Foreign Exchange Management Act (FEMA), 1999; Monopolistic and

Restrictive Trade Practices (MRTP), Act, 1969; Competition Act, 2002; Food safety and standards Act, 2006; Customs Act, 1962 and Goods and Service Tax, 2011. FDI Policy of GoI. Business Ethics - Nature and importance of ethics and moral standards. Scope of business ethics in business functional area. Governance mechanism. Companies Act Amendment 2023, OPC, FPC, Section 8.

Suggested Readings

1. Business Law and Ethics- Concepts, Methodologies, Tools, and Applications 2015. Editor: Information Resources Management Association.
2. Business Law and Ethics: Concepts, Methodologies, Tools, and Applications.
3. Business Law and Ethics: Concepts, Methodologies, Tools, and Applications. Volume 1. Business Science Reference, 2015.

International Trade and Policy in Agriculture 2 (2+0)

Objectives

1. Understand the principles and mechanisms of international trade in agricultural commodities
2. Learn about agricultural trade policies, agreements, and their impacts on global markets
3. Explore strategies for market access, trade negotiations, and resolving trade disputes in agriculture
4. Develop skills to analyze international trade trends, assess market opportunities, and navigate regulatory frameworks to facilitate agricultural exports and imports

Theory

International Trade - meaning, definition, nature and scope. Salient features of international trade, differences between internal trade and international trade, advantages and disadvantages of international trade.

Theories of international trade - mercantilism, theory of absolute cost advantage, theory of comparative cost advantage and modern theory of international trade. Terms of trade - meaning and types. Free trade - meaning, advantages and disadvantages, free trade agreements.

Protectionism - meaning, advantages and disadvantages of protectionism, types of protection - tariffs, quotas, subsidies, dumping, cartels and commodity agreements. Balance of Trade (BoT) and Balance of Payments (BoP) - meaning, differences between BoT and BoP, India's BoT and BoP position. Foreign exchange – meaning, foreign exchange rate, types of foreign exchange rate, mechanisms of determining foreign exchange rate. Foreign exchange market – meaning and functions, instruments of international payments, foreign exchange control and foreign exchange reserves.

WTO – origin, structure, objectives and functions. Agreement on Agriculture - domestic support, market access and export subsidies. FAO / WHO Codex Alimentarious and SPS measures.

Export procedures and documentations, types of export - direct export and indirect export, export houses – objectives and types. Agricultural export promotion organizations - APEDA, MPEDA, Commodity Boards and State Export Promoting Agencies. India's agricultural exports and imports – composition and trading countries. India's foreign trade policy – meaning and objectives.

Suggested Readings

1. Ajami, Riad A. - International Business- Theory and Practices.
2. Cherunilam and Dominick Salvatore - International Economics.
3. Cherunilam, Prancis - International Trade and Export Management.
4. Haberler, G. - Theory of International Trade.
5. Jain, Arun Kumar - International Business.
6. Jhingan, M.L. - International Economics.
7. Justin Paul - International Business.
8. Mithani, D.M. - Money, Banking, International Trade and Public Finance.
9. Tappa, Ashwa - International Business.
10. Vaish, M.C. and Singh, Sudham– International Economics.
11. Venkateshwaran, N. - International Business Management.

Agricultural Marketing Regulations 3 (2+1)

Objectives

1. Understand the regulatory framework governing agricultural marketing at local, national, and international levels
2. Learn about marketing laws, policies, and regulations affecting the sale and distribution of agricultural products
3. Explore the role of government agencies and industry organizations in enforcing marketing regulations and ensuring fair trade practices
4. Develop skills to navigate compliance requirements, understand market access regulations, and mitigate legal risks in agricultural marketing activities

Theory

Evolution of market legislation. Need and scope for market legislation. Review of Agricultural Produce Market Acts in India and Karnataka. Distribution of legislative powers between parliament and state assemblies. Salient features of essential commodities Act-Food Safety and Standards Act 2006, Consumer Protection Bill 2019, Patent Act 2002, Monopolies and Restrictive Trade Practices Act/ Competition Act 2002, Forward Markets Act 1952, Standards of Weights and Measures Act 1976, The Central Warehousing Corporation Act. Provisions of Karnataka Agricultural Marketing (Development Regulation) Act 2007 – Establishment of Market, Constitution of Market Committee (APMC), Special Market, Conduct of Business of the Market Committee, Powers and Duties of Market Committee, Staff of the Market Committee, Regulation of the Contract Farming Trade, Karnataka State Agricultural Marketing Board - Constitution and Functions. Role of state department of Agricultural Marketing and Directorate of Agricultural Marketing and Inspection. Agricultural Marketing Policies of the Government – Administered Price Policies – Commission for Agricultural Costs and Prices (CACP) and its Working. Policies of Procurement, Levy and Public Distribution System. Minimum Support Prices, Ceiling Price and Parity Prices. Floor Price Scheme. Food Security Policy - Procurement, Buffer Stock, Distribution, Subsidies. Food Zone. Agri Export Zones (AEZS)/ Export Oriented Units (EOUS). Introduction and Meaning of Intellectual Property, Brief Introduction to GATT, WTO, Trips

and WIPO, Treaties for IPR Protection: Madrid Protocol, Berne Convention, Budapest Treaty, etc. Types of Intellectual Property and Legislations Covering IPR in India: Patents, Copyrights, Trademark, Industrial Design, Geographical Indications, Integrated Circuits, Trade Secrets. Patents Act 1970 and Patent System in India, Patentability, Process and Product Patent, Filing of Patent, Patent Specification, Patent Claims, Patent Opposition and Revocation, Infringement, Compulsory Licensing, Patent Cooperation Treaty, Patent Search and Patent Database.

Practical

Evolution and Historical Perspectives of Agricultural Marketing Legislation, Marketing Tax and Fees, Different Agents Involved in Marketing Practices, Study on Different Agricultural Marketing Models, Review of Agricultural Marketing Policies. Study on Reform in Agricultural Marketing Sectors in India. Presentation and group discussions on above topics, Visits to different APMC's.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 1994, Agricultural Prices- Analysis and Policy, Oxford and IBH, New Delhi.
2. Encyclopaedia of Agricultural Marketing- Market Regulation and Development (Vol. 3) by Jagdish Prasad. 1999.
3. Kahlon, A.S. and George, M.V., 1965, Agricultural Marketing and Price Policies, Allied Publishers Private Limited, New Delhi.
4. The Karnataka Agricultural Produce Marketing (Regulation and Development) Act 1966 by Sathpal Puliani. 2020.

Principles of Management and Organizational Behaviour 2 (1+1)

Objectives

1. Understand the fundamental principles of management theory and practice.
2. Explore the dynamics of organizational behaviour, including individual and group dynamics, communication, and motivation
3. Learn to apply management concepts and behavioral theories to solve organizational challenges and improve effectiveness
4. Develop skills in leadership, decision-making, and conflict resolution to enhance organizational performance and employee satisfaction

Theory

Introduction to Management - Management functions - Management levels - Managerial roles - Management skills - Role of management. Evolution of management thought.

Functions of management: Planning: Nature and importance - types of planning - Steps in planning - Decision making – meaning - types of decisions.

Organizing- meaning-nature and purpose of Organizing-Principles of organizing-Organization structure -Managing Human Resources- human resource planning- recruitment-sources of recruitment -Selection- steps in the selection process- Orientation -Training -Management development program s.

Leading- meaning - Leadership theories - Motivation-Meaning and purpose- Motivational theories - Communication-meaning-objectives-importance-types- barriers.

Controlling-meaning and nature of controlling-essential elements of controlling. Ethics and corporate social responsibility in business.

Organizational Behaviour - definition, importance, historical background of Organizational Behaviour, challenges - the organizational Context-Environment – Technology.

Learning - importance of learning -Process-approaches to learning-the learning organization.

Personality-defining personality-types and traits-personality types-the big five-the development of the self-selection methods.

Perception- meaning, selectivity and organization-perceptual sets and perceptual worlds-factors influencing perception and shortcuts in judging others.

Group Dynamics - meaning, need for joining groups, stages of group development and group decision making techniques. Teams-types, difference between teams and groups. Managing conflicts. Work stress – Types and management strategies. Organizational culture – Definition and creating a culture in organization. Organizational change.

Practical

Study of management structure and organizational pattern of selected business units. Preparation, analysis and presentation of case studies.

Suggested Readings

1. Aaker, David, Kumar, V. and George Day, 1995, Marketing Research, 8th edn, John Wiley and Sons.
2. Andrew J. Dubrin, 2012, Essentials of Management, Thomson Southwestern, 9th edition.
3. Charles W.L. Hill and Steven L. McShane, 2007, Principles of Management, McGraw Hill Education, Special Indian Edition.
4. Harold Koontz and Heinz Weihrich, 2012, Essentials of Management: An International and Leadership Perspective, 9th edn, Tata McGraw- Hill Education.
5. Kerlinger, Fred N., 1986, Foundations of Behavioural Research, 3rd edn.
6. Kotler P., 2001, Marketing Management. Grada, Praha, 10th edn.
7. Koudelka J., 1997, Consumer Behaviour and Marketing. Grada, Praha.
8. Michael A. Kamins, 1993, Secondary Research: Information, Sources and Methods, Applied Social Research Methods, Volume 4, Sage Publications.
9. Samuel C. Certo and Tervis Certo, 2012, Modern Management: Concepts and Skills, Pearson education, 12th edn.

Farm Machinery and Power and Custom Hiring Services 2 (1+1)

Objectives

1. Understand the principles and operation of farm machinery and power equipment

2. Learn about the selection, maintenance, and efficient use of agricultural machinery for various farm operations
3. Explore the concept and benefits of custom hiring services in agriculture
4. Develop skills to optimize farm machinery usage, reduce operational costs, and improve overall farm productivity through efficient machinery management and custom hiring services

Theory

Status of Farm Power in India, Sources of Farm Power, I.C. engines, working principles of I.C. engines, comparison of two stroke and four stroke cycle engines. Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor, Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow. Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter. Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

Suggested Readings

1. Jagadishwar Sahay, Elements of Agricultural Engineering, Standard Publishers Distributors, New Delhi.
2. Michael A.M. and T.P. Ojha, Principles of Agricultural Engineering (Vol-I), Tata McGraw Hill Publishing Co Ltd, New Delhi.
3. Nakra, C.P. Farm Machinery and Equipments, Dhanpat Rai and Sons, New Dehli.
4. Singhal O.P., Elements of Agricultural Engineering, Merath Aman Public House, Meerut.

Post-harvest Management and Value Addition of Fruits and Vegetables 2 (1+1)

Objectives

1. Understand the principles and techniques of post-harvest management for fruits and vegetables
2. Learn about value addition processes such as sorting, grading, packaging, and processing
3. Explore methods to minimize post-harvest losses and extend the shelf life of fruits and vegetables

4. Develop skills to add value to agricultural produce, increase marketability, and enhance profitability for farmers and stakeholders

Theory

Importance of post-harvest processing of fruits and vegetables; Extent and possible causes of post-harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, Cold storage, CA, MA and Hypobaric); Value addition concept; Principles and methods of preservation; Minimal processing; Intermediate moisture foods- Jam, Jelly, Marmalade - Concepts and Standards; Fermented and non-fermented beverages; Drying/ Dehydration of fruits and vegetables - Concept and methods; Canning - Concepts and Standards, Packaging of products.

Practical

Containers for shelf life extension; Effect of temperature on shelf life and quality of produce; Chilling and freezing injury in vegetables and fruits; Extraction and preservation of pulps and juices; Preparation of Jam, Jelly, RTS, Nectar, Squash, Wine, Fruit bar, Candy, Tomato products; Quality evaluation of products- physico- chemical and sensory; Visit to processing unit/ industry.

Suggested Reading

1. Bhutani, R.C., 2003, Fruit and Vegetable Preservation, Biotech Books.
2. Mitra, S.K., 1997, Post Harvest Physiology and Storage of Tropical and Sub-Tropical Fruits, CABI.
3. Ranganna, S., 1997, Handbook of Analysis and Quality Control for Fruit and Vegetable Products, Tata McGraw-Hill.
4. Sudheer, K.P., and Indira, V., 2007, Post Harvest Technology of Horticultural Crops, New India Publ. Agency.
5. Willis, R., McGlassen, W.B., Graham, D. and Joyce, D., 1998, Post Harvest: An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals, CABI.

Entrepreneurship Development and Business Management 3 (2+1)

Objective

1. To provide student an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment

scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management. Himalaya Publishing House.
3. Desai, Vasant, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House.
4. Grover, Indu, 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Gupta C.B., 2001, Management Theory and Practice. Sultan Chand and Sons.
6. Khanka S.S., 1999, Entrepreneurial Development. S. Chand and Co.
7. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
8. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D., 1995. Effective Managerial Leadership. Deep and Deep Publ.
10. Singhal R.K., 2013, Entrepreneurship Development and Management. Katson Books.
11. Tripathi P.C. and Reddy P.N., 1991, Principles of Management. Tata McGraw Hill.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes,etc.
2. Toprovide basic knowledge of computer with applications in agriculture

3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system. Definition and types, applications of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical analysis, mathematical expressions, database, concepts and types, creating database. Uses of DBMS in agriculture, internet and World Wide Web (WWW); concepts and components.

Computer programming: General concepts. e-Agriculture, Concepts, design and development, application of innovative ways to use information and communication technologies (IT) in agriculture, computer models in agriculture. Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops. Computer-controlled devices (automated systems) for agri-input management, smart phone mobile apps in agriculture for farm advice. Market price, postharvest management, etc. Geospatial technology; concepts, techniques, components and uses for generating valuable agri-information. Decision support systems; concepts, components and applications in agriculture. Agriculture expert system, soil information systems, etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File management. Use of MS-Word and MS Power-point for creating, editing and presenting a scientific document, MS-EXCEL-Creating a spreadsheet. Use of statistical tools. Writing expressions, Creating graphs, Analysis of scientific data. MS-ACCESS, creating database, preparing queries and reports, demonstration of agri-information system, Introduction to World Wide Web (WWW) and its components, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA), AR/VR Demonstration.

Suggested Readings

1. Date CJ, 2007, An Introduction to Database Systems, Addison-Wesley.

2. Dhabal PS and Manoranjan P, 2017, Concepts and Techniques of Programming in C, I.K. International Publishing House Pvt. Limited.
3. ITL Education Solutions Ltd, 2006, Introduction to Information Technology, Pearson Education.
4. Mahapatra SK, Mishra P and Pradhan J, 2022, Introductory Agri Informatics, Jain Brothers.
5. Rajaroman V and Adabala N, 2015, Fundamentals of Computer, PHI Learning Private Ltd, New Delhi.

SEC-6: Development of Agribusiness Proposal **2 (0+2)**

Objectives

1. Learn to identify viable agribusiness opportunities and formulate innovative project proposals.
2. Understand the components and structure of a comprehensive agribusiness proposal, including market analysis, financial projections, and risk assessment.
3. Develop skills to effectively communicate business ideas, secure funding, and implement successful agribusiness ventures.
4. Gain practical experience in preparing and presenting agribusiness proposals that meet the needs of stakeholders and investors.

Practical

A. Project Planning, Monitoring and Evaluation: Orientation. Hands on experience on preparation of project proposals for horticulture crops, dairy, poultry and agro-processing units. Interaction with staff/experts for midterm corrections and submission of interim report. Hands on experience on preparation of project proposal for bio-fertilizer and bio-pesticides units, irrigation, equipments and machineries, forest plantations, fishery and land development activities. Interaction with staff/ experts for midterm corrections and submission of interim report. Hands on experience on ex-ante, concurrent and ex-post appraisal. Hands on experience on discounting procedures like NPV, IRR and BCR, preparation of techno-economic feasibility reports of project. Report writing and examination.

B. Marketing Management: Orientation. Hands on experience on conducting market survey to gain experience on working out consumer profile, competitors, substitutes and their price and features. Designing market strategy. Interaction with staff/experts for midterm corrections and submission of interim report. Hands on experience on forecasting market demand. Pricing methods, creating and organizing an advertising campaign. Various packaging materials used for agro-based products. Product distribution network, marketing cost, marketing planning process. Interaction with staff/ expert for midterm corrections and submission of interim report. Hands on experience on marketing research and information system for new product development and options for extending product life cycle. Spot and online marketing. Export- import policies for agriculture sector. Report writing and examination.

C. Financial Management: Orientation. Estimation of funds required – capital investment and operational expenses. Share of owned and borrowed funds in the business. Sources of borrowed funds, terms and conditions of borrowings, repayment schedule, cash inflow and cash outflows of business. Interaction with staff/ experts for midterm corrections and submission of

interim report. Hands on experience on accounting methods and procedures. Commonly used account systems, the single and double entry system, recording transactions, journals, figures, trial balance, assets and liabilities. Revenue cost of sales and net profit operating and incidental expenses and inventory. Interaction with staff / experts for midterm corrections and submission of interim report. Preparation of financial statements like balance sheet, income statement, profit and loss statement for the business. Exercise on financial ratio analysis. Report writing and examination.

Suggested Readings

1. David D. Van Fleet and George J. Seperich. 2013. Agribusiness: Principles of Management. Delmar, New York.
2. Elizabeth Yeager, Frank J. Dooley, Freddie L. Barnard, Jay T. Akridge and John Charles Foltz. 2012. Agribusiness Management. Routledge, London.
3. Hegde P. 2012. Agribusiness Management. Discovery Publishing House, New Delhi.
4. Karthikeyan M. and Nakkiran S. 2012. Co-operatives and Agri-Business. Discovery Publishing House, New Delhi.
5. Walter David Downey. 1987. Agribusiness Management. Tata McGraw-Hill, New Delhi.

Semester V

Grading, Standardization and Quality Management in Agri-food Products 2 (1+1)

Objectives

1. Understand the principles and methods of grading and standardization for agri-food products
2. Learn techniques to ensure product quality and consistency in the agricultural supply chain
3. Explore quality management systems and certifications applicable to agri-food products
4. Develop skills to implement grading, standardization, and quality management practices to meet market requirements and consumer expectations

Theory

Evolution of markets- meaning of market, marketing, Agril. Marketing. Concept of marketing – old concept, new concept and modern concept. Significance / need of Agril. Marketing, creation of utilities. Classification of markets. Marketing functions- Physical functions, exchange functions and facilitative functions. Grading and standardization Meaning-Significance of grading and standardization. Types of grading- fixed grading/mandatory grading, permissive/variable grading, centralized grading/decentralized grading and Grading at producers' level. Criteria for grade standards and advantages of grading. Role of grading in Agril. Products. The agricultural produce (Grading and Marketing) Act, 1937. Quality control of Agril. Products, AGMARK standards, the role of DMI in grading of Agril. Produce, Inspection and quality control, labelling in Agril. Products. Grading of food grains- grading of Rice commercial classification, based on physical characteristics, cooking quality of rice, Rice grading by AGMARK. Special characteristics, general characteristics, safety parameters, determination of quality of rice. Impurities refractions of food grains foreign matter- organic and inorganic, admixtures, damaged and discolored grains, slightly damaged grains and immature and shriveled grains, Chalky, weevils, broken, fragments, other food

grains, non-food grains, Smutty grains, whole grains. Inherent and acquired characteristics of food grains. Wheat- quality characteristics of wheat varieties, Wheat- strong wheat flour, medium and medium flour, kinds of wheat. AGMARK quality specifications for wheat, safety parameters and determination of quality of wheat. FAQ standards for Rice, Wheat, Ragi, Maize. Grading of Pulses, AGMARK standards for Green gram (moong), Red gram (tur dal), Bengal gram, Black gram urad dal), Rajma, Peas, Masoor (lentils), Matki (moth). Grading of oil seeds: Groundnut, Sunflower. AGMARK standards of oil seeds. Commercial classification of Groundnut- Coramandal, Bold, Red natal and Peanuts. Grading of pods and kernels of groundnut. AGMARK grade designation of quality of edible oil. Grading of commercial crops- special and general characteristics of Areca nut, copra, Tobacco and Cotton, chilli. Classification and grading of vegetables: Cole, Tuber, Pod, Salad, Root and Bulb vegetables. Grading of fruits- Tropical fruits, Mango, Banana, Citrus, Grapes, Sapota and Pomegranate. Temperate fruits: Apple, Pears, Plums, Apricots and Peaches. Quality control of manufactured products Indian Standards Institution (ISI): aims and objectives of ISI, granting licenses for ISI, Bureau of Indian Standards (BIS), management systems certification. Spot exchange grade requirements, Mark to identify vegetarian/non vegetarian food, Eco mark. Mark of FPO and ISO standards. Quality control in food- food hygiene, food adulteration and food poisoning. Good Agril. Practices, good manufacturing practices. EUREPGAP Quality management in food: FSS Act 2006, Hazard Analysis and Critical Control Point (HACCP), Codex Alimentarius commission (CODEX), Fair Average Quality (FAQ), General Characteristics and grade designations of processed food- Jaggery, instant food, fruits and vegetables products.

Practical

Study of laboratory equipment, Sampling equipment, scientific grading, instruments and other apparatus, Visit to vegetable and fruit markets, Jaggery market and other food processing units. Visit to Bureau of Indian Standards. Presentations and Group discussions for the above topics.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2000, Agricultural Marketing in India.
2. Chakravarty, A. and De, D.S., 1981, Post harvest technology of cereals and pulses, Oxford and IBH, Calcutta.
3. Jambunathan, L.R., 1984, Grading of cotton for quality: A scoring system of instrumental evaluation for Cotton Hybrid-4.
4. Mamoria, C.B., 1976, Agricultural Problems of India, Kitab Mahal, Allahabad.
5. Manual on Grading and Standardization, Directorate of Marketing and Inspection (DMI), Nagpur.
6. Manual on Standards, Bureau of Indian Standards (BIS), New Delhi.
7. Wader, L.K. and C., Murthy, 2003, Textbook of agricultural marketing and cooperation, ICAR, New Delhi.

Market Information and Intelligence **3 (2+1)**

Objectives

1. Understand the importance of market information and intelligence in making informed business decisions

2. Learn methods for collecting, analyzing, and interpreting market data and trends
3. Explore strategies to use market information to identify opportunities, mitigate risks, and gain competitive advantage
4. Develop skills to effectively utilize market intelligence to optimize marketing strategies, pricing, and product positioning in agribusiness

Theory

Market Information-Meaning, Need for market information, Merits of Market Information, Importance of market information - Types of Market Information- Market Intelligence, Market News and Market Outlook - Essential Characteristics of Good Market Information and means of data collection. Compilation, analysis and dissemination of market information and intelligence in India. Sources of compilation and dissemination of market information-institutional and non-institutional. Deficiencies, problems and reliability of market information. Simple forecasting tools for price and demand estimation: time series analysis (trend, seasonal indices), Consumer surveys, Expert opinion survey methods, Market experiments methods, Graphical methods, smoothing techniques and regression methods. Evaluation of forecasts.

Practical

Price and demand analysis of selected agricultural commodities using time series analysis, Consumers' surveys, Experts' opinion survey methods, Market experiments methods, Graphical methods, smoothing techniques, Delphi method and regression methods. Developing market intelligence and information reports.

Suggested Readings

1. Acharya, S.S., 1988, Agricultural Production, Marketing and price policy- A study of Pulses, Mittal Publications, Delhi.
2. Acharya, S.S., and Agarwal, N.L., 1994, Agricultural prices- Analysis and policy, Oxford and IBH, New Delhi.
3. Alexander, Market Intelligence.
4. Fox, Market Information system.
5. Gupta, A.P., 1975, Marketing of agricultural production in India, Voro and Co-Publishers Pvt. Limited, Bombay.
6. Jagadish Prasad, 1966, Encyclopedia of Agricultural Marketing, Mittal Publishers Pvt. Limited, Bombay.
7. Kahlon, A.S. and George, M.V., 1965, Agricultural marketing and Price Policies, Allied Publishers Private Limited, New Delhi.
8. Nayyar, H. and Ramaswamy, P., 1995, Globalization and Agricultural Marketing, Rawat Publications, Jaipur.
9. Prasad, A. Shivarama, Agricultural Marketing in India, Mittal Publications, Delhi.
10. Singhal, A.K., 1989, Agricultural Marketing in India, Anmol Publications, New Delhi.

Capital and Commodity Markets 2 (1+1)

Objectives

1. Understand the functioning and dynamics of commodity markets in agriculture
2. Learn about price discovery mechanisms, trading strategies, and risk management techniques
3. Explore the factors influencing supply and demand dynamics in commodity markets
4. Develop skills to analyze commodity market trends, assess market opportunities, and make informed trading decisions in agricultural commodities

Theory

Capital market instruments – corporate stock and corporate bonds - Capital market instruments – commercial paper, certificate of deposits - Equities - Common Stocks, Restricted Shares- Preferred Stocks - Fixed income capital market instruments – Bonds, debentures, swap and Mortgage-backed securities-Managing Interest Rate Risk - The Yield Curve - Process and procedures of raising equity capital - Types of investors in capital market - Depository services – meaning and functions - Insider trading - Transaction procedures and settlement- Stock Valuation.

History and evolution of commodity markets. Marketing of food grains – cereals and pulses, production, consumption, marketable surplus. Marketing of commercial crops: coffee, tea, rubber, tobacco, Arecanut, coconut, cotton, oilseeds, spices, jute - supply and demand. Marketing practices, market structure, marketing channels and price spread, organizations and institutions, Commodity Boards and their activities. Marketing of horticultural crops – Fruits, vegetables and flowers - demand, supply and utilization, marketing practices, NHB, NHM, APEDA. Role of commodity exchanges-difference between national and regional exchanges. Meaning and types of market participants – Hedgers, Speculators, Arbitragers. Derivatives market – meaning, functions and limitations. Types of derivatives - options, forward, futures and swaps. Factors influencing spot and futures markets. Trading strategies. Pricing of futures. Operational mechanism of commodity markets. Settlement process and delivery mechanisms. Strategies using options to hedge risks, long and short positions. Role of banks and warehousing in commodity markets - Global commodity exchanges dealing with agricultural commodities.

Practical

Compilation of basic statistics on area, production, productivity, consumption, export and import of selected crops. Estimating growth. Graphical representation. Visit to Grain Market, Fruit, vegetable and flowers markets. Futures pay-offs calculation. Pricing of derivatives.

Suggested Readings

1. Carter Colin A. 2003. Futures and Options Markets: An Introduction, Prentice-Hall: Upper Saddle River, NJ.
2. Chatnani, Niti Nandini. Commodity Markets, Tata McGraw Hill Education Private Limited, New Delhi.
3. Hull John C. 2005. Fundamentals of Futures and Options Markets, 5th edn, Prentice Hall: Upper Saddle River, NJ.
4. Kulkarni, Bharat. Commodity Markets and Derivatives, Excel Books, A-45, Naraina, Phase I, New Delhi.

5. McDonald and Robert L. 2006. Derivatives Markets, 2nd edn, Addison Wesley: Boston.
6. Wayne Purcell and Stephen Koontz. 1999. Agricultural Futures and Options, Principles and Strategies (2nd edn), Prentice-Hall (ISBN 0-13-779943-8).

Cooperatives and Producers' Organizations 3 (2+1)

Objectives

1. Understand the principles and structures of cooperatives and producers' organizations in agriculture
2. Learn about the benefits and challenges of cooperative business models for smallholder farmers and producers
3. Explore strategies for organizing, managing, and governing agricultural cooperatives and producers' organizations effectively
4. Develop skills to foster collaboration, collective marketing, and value addition through cooperative and producer-led initiatives in agriculture

Theory

Management of cooperative enterprises: Concept, Meaning, definition, unique features–Issues in cooperative management–Cooperative Governance-Human resource development in cooperatives- Professionalization of cooperatives. Co-operative management structure: Role and responsibilities of General Body, Board of Directors, President and Chief Executive Officer. Decision making in cooperatives- Performance evaluation parameters for co-operatives. Capital and cooperatives–Meaning-Purpose of Equity-Equity Management and cooperatives -The Importance of Financial Planning -Equity Types -Equity Management Considerations. Producer Organizations: concept, meaning, types, characteristics and scope. Process guidelines for promotion of FPOs. Steps in Registration of PCs. Management of Producer Companies: Membership, Powers of General Body, powers of Executive Committee, Funds, accounts and audit, appropriation of net profit. Role of central and state governments in supporting FPOs, Role of NABARD in promoting Producer Organizations.

Practical

Case studies on evaluation of the performance of co-operative organisations. Case studies on democratic decisions and ethical dilemma. Assessing capital requirements of a Producer Company, Assessment of financial viability of the business of Producer Companies, Assessing institutional performance of Producer Company.

Suggested Readings

1. A Guide Book for Producer Organization (PO) and Producer Group (PG), 2018 by Prabir Datta.
2. Farmer Producer Organisations, 2015, National Bank for Agriculture and Rural Development.
3. Making Farmer Producer Organizations Achieve Viability: A Practical Guide, 2021 by Sanjiv Phansalkar and Avinash Paranjape.
4. State of Sector Report - Farmer Producer Organizations in India, 2021 by Sanjiv Phansalkar, Vedprakash, Aneesha Bali and Anish Kumar.

Business Research Methods 3 (2+1)

Objectives

1. Understand various research methodologies and their application in business settings
2. Learn how to formulate research questions, design studies, and collect data for business analysis
3. Develop skills to critically evaluate research findings and apply them to business decision-making
4. Gain proficiency in using statistical tools and software for data analysis in business research

Theory

Business Research– Meaning, types, importance and characteristics of good research. Ethics in business research. Research proposal - purpose, types and its importance. Research process – Problem identification. Developing an Approach to the problem. Research design - definition, classification and types. Sampling design- Meaning, steps in sampling design and process. Types of sampling: Probability and Non-probability sampling. Determining sample size. Meaning and types of Sampling error. Data sources – primary and secondary data types. Data Collection Methods: Observations, survey and interview. Focus group discussion and panel data. Measurement and scaling techniques – basic scales of measurement, scaling techniques. Attitude measurement – Likert scale. Data editing, coding, classification, tabulation. Data Analysis – qualitative and quantitative methods. Use of parametric and nonparametric tests: T-test, Z-test, F-test, Chi-square test and ANOVA and its applications – Correlation, simple and multiple regression techniques. Steps in report writing.

Practical

Preparing business research proposal – Problem identification and research questions, formulation of research design, sampling framework and hypothesis. Data mining - Collection of primary and secondary data – Sources. Preparation of interview schedule and questionnaire for primary data collection - Administration of mailed questionnaire and on-line survey. Conducting field level enquiry and data collection. Organizing other methods of data collection - Focus group discussion/panel data collection / observation / case study. Application of scaling techniques in business research. Data editing - coding and tabulation - Application of statistical tools (Descriptive statistics) in business research. Understanding cause and effect and functional relationships among the variables.

Suggested Readings

1. Cooper D.R. and P. S. Schindler, 2007, Business Research Methods, Tata McGraw Hill Company Ltd.
2. Kothari C.R., 2007, Research Methodology, New Age International Publishers.
3. Andrea Ahlemeyer-Stubbe and Shirley Coleman, A Practical Guide to Data Mining for Business and Industry, John Wiley and Sons Limited, United Kingdom (e book).
4. Ledolter, Johannes, Data Mining and Business Analytics with R, John Wiley and Sons, New Jersey (***e - Book***).

Sustainable Farming Systems and Precision Agriculture 2 (1+1)

Objectives

1. Understand the principles and practices of sustainable farming systems aimed at environmental stewardship and resource conservation
2. Learn about precision agriculture technologies and their applications for optimizing inputs, minimizing waste, and increasing farm efficiency
3. Explore strategies to integrate sustainable practices and precision agriculture techniques for improved crop productivity, profitability, and environmental sustainability
4. Develop skills to implement and manage sustainable farming systems and precision agriculture technologies to address challenges such as climate change, soil degradation, and water scarcity in agriculture

Theory

Farming System-scope, importance, concept and types. Farming systems components, Indicators of Sustainability, adaptation and mitigation, determining production and efficiencies in cropping and farming systems; Sustainable agriculture- problems and its impact on agriculture. Evaluation indices for cropping system. Integrated Farming System- historical background, objectives and characteristics, components of IFS and its advantages, resource use efficiency and optimization techniques. Operational structure of NPOP. Organic certification process and economic considerations. Marketing export potential of organic products.

Precision agriculture: components, concepts and principles, techniques, their issues and concern for Indian agriculture. Global Positioning System (GPS) and Geographical Information System (GIS), Site Specific Nutrient Management (SSNM) for nutrient and irrigation management practices. Comparative yield, quality and farm profits under SSNM practices v/s Variable Rate Technology (VRT) practices. Yield monitoring and mapping.

Practica

Tools for determining production and efficiencies in cropping and farming system, Visit cropping systems and IFS models. Evaluation indices for cropping system. Organic farming guidelines and alternative philosophies. Organic nutrient resources and their fortification, Restrictions on nutrient use, enriched compost, vermi-compost, liquid organic manures, green manuring, crop residue management, biofertilizers/bio inoculants and their quality. ITKs in organic farming. NPOP: certification process and standards of organic farming; processing, labelling, marketing and export of organic products. Economic of Organic production systems. Visit to organic farmer's fields.

Use of GPS for agricultural survey and recording the observations with GPS. Area estimation, navigation and recording elevation points. Conversion of GPS readings, Study of maps, top sheets, cartography, GPS software's, Spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. VRT, Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Use of UAV in agriculture.

Suggested Readings

1. Joshi M and Prabhakarashetty TK. 2005. Sustainability through Organic Farming, Kalyani Publishers.
2. Palaniappan SP and Anandurai K. 1999. Organic Farming - Theory and Practice, Scientific Publishers.
3. Panda SC, 2014, Cropping and Farming System. Agrobios (India) Publishers.
4. Reddy, S. R., 2017. Geoinformatics and Nanotechnology for Precision Farming. Kalyani Publishers. pp.140.
5. Thomas Lillesand, Ralph W. Kiefer and Jonathan Chipman. 2015. Remote Sensing and Image Interpretation, 7th Edition, Wiley Publications. Pp 736.
6. Wright, Richard T. and Bernard J. Nebel Environmental science: toward a sustainable agriculture.

Intellectual Property Rights 1 (1+0)

Objectives

1. Understand the principles and significance of intellectual property rights (IPRs) in agriculture
2. Learn about different types of IPRs such as patents, trademarks, and plant breeders' rights
3. Explore the legal and ethical implications of IPRs in agricultural innovation, research, and commercialization
4. Develop skills to protect, manage, and utilize intellectual property assets effectively in agricultural enterprises

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Beme Convention, Budapest treaty, etc. Types of intellectual Property and legislations covering IPR in India- Patents, Copyrights, Trademark, Industrial design, Geographical indications, Appellations of origin, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database. Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV and FR Act of India, Plant breeder's rights, Registration of plant varieties under PPV and FR Act 2001, breeders, researcher and farmer's rights. Traditional knowledge- meaning and rights of TK holders. Convention of Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

Suggested Readings

1. Intellectual Property Rights - Unleashing the knowledge economy, 2001, Ganguly P., Tata McGraw Hill.
2. Intellectual Property Rights in Agricultural Biotechnology, 1998, Erbisch, F.H. and Maredia, K., CABI.

3. Intellectual Property Rights in Animal Breeding and Genetics, 2003, Rothschild M. and Scott N. (Ed.), CABI.
4. Intellectual Property Rights in NAM and other Developing Countries: A Compendium on Law and Policies, 2006, Saha, R. (Ed.). Daya Publ. House.
5. Ministry of Agriculture, Government of India 2004. State of Indian Farmer. Vol V. Technology Generation and IPR issues. Academic Foundation.
6. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act,2003.
7. WIPO Intellectual Property Handbook: Policy Law and Use. Fields of Intellectual Property Protection, WIPO, 2008.

Fundamentals of Plant Biotechnology 2 (2+0)

Objectives

1. Understand the principles and techniques of plant biotechnology
2. Learn about genetic engineering, gene editing, and other biotechnological methods used in plant breeding
3. Explore the applications of plant biotechnology in crop improvement, pest resistance, and stress tolerance
4. Develop skills to critically evaluate the ethical, environmental, and regulatory aspects of plant biotechnology

Theory

Introduction, history, concepts and applications of plant biotechnology, cell, DNA structure and function, gene cloning steps, common enzymes used as molecular tools, vectors, transformation and selection of recombinants, construction of genomic libraries, isolation and cloning of coding parts of eukaryotic genes-cDNA cloning. Gene transfer methods, transgenics and its importance, gene editing, biosafety measures and intellectual property rights. Molecular markers, RAPD, RFLP, SSR, SNP etc, and their applications. Concept of tissue culture, organogenesis and embryogenesis, embryo rescue and its significance, micropropagation, somaclonal variation and its use in crop improvement, synthetic seeds and their significance, somatic hybridization and cybrids and cryo-preservation. Use of tissue culture in biotechnology (transgenics and gene editing).

Suggested Readings

1. Brown, T.A., 2006, Gene cloning and DNA analysis: An introduction, Blackwell Publishing, Oxford, UK.
2. Chawla, H.S., 2002, Introduction to Plant Biotechnology, Science Publishers.
3. Gardener, E.J., Simmons, M.J. and Snustad, D.P., 1991, Principles of Genetics, John Singh, B.D., 2013, Biotechnology, Kalyani Publishers.
4. Wiley and Sons, Inc, New York, USA.

Social Entrepreneurship 1 (1+0)

Objectives

1. Understand the concept and principles of social entrepreneurship
2. Learn about innovative business models that address social and environmental challenges
3. Explore strategies for creating sustainable social impact while ensuring financial viability
4. Develop skills to identify social problems, design solutions, and implement projects that benefit communities

Theory

Social Entrepreneurship: concept, meaning, historical perspective of social entrepreneurship. Factors impacting transformation into social entrepreneurship. Characteristics of social entrepreneurs. Differences between business and social enterprise. Forms of social enterprises, Profit and non-profit Proprietorships, partnership and company; Non-Governmental organisation, Trust and Company. Third Sector Organizations (TSOs) and social enterprises. Similarities and differences with other forms of enterprises. Organisation of social enterprise. Financing of social enterprise. Legal compliance and management of resistance. Management: strategy, finance, HRM and marketing. Governance challenges - accountability, transparency and democracy. Measurement of social outcomes and impact, social accounting, social return on investment. Innovations in social enterprises. Successful social enterprises in India.

Suggested Readings

1. Bornstein, David and Susan Davis. 2010. Social Entrepreneurship: What Everyone Needs to Know? Oxford University Press, New York.
2. Bornstein, David. 2007. How to Change the World: Social Entrepreneurs and the Power of New Ideas. Oxford University Press, New York.
3. Doherty, Bob, George Foster and Chris Mason. 2009. Management for Social Enterprise. Sage Publications, USA.
4. International Journal of Social Entrepreneurship and Innovation, Inderscience.
5. Journal of Social Entrepreneurship, Taylor and Francis.
6. Praszkier, Ryszard and Andrzej Nowak. 2011. Social Entrepreneurship: Theory and Practice. Cambridge University Press, Cambridge.
7. Yunus, Muhammad. 2010. Building Social Business: The New Kind of Capitalism that Serves Humanity's Most Pressing Needs. Public Affairs, New York.

Applied Business Statistics 2 (1+1)

Objectives

1. Understand the fundamental concepts and techniques of statistical analysis in business contexts
2. Learn how to collect, organize, and interpret data to make informed business decisions
3. Explore the application of statistical tools and methods in various business functions such as marketing, finance, and operations
4. Develop skills to use statistical software packages effectively for data analysis and visualization in business settings

Theory

Introduction to Sampling Theory, Sampling versus Complete Enumeration, Methods of Sampling: Probability sampling design –Simple Random Sampling (WR and WOR), Use of Random Number Tables for selection of Simple Random Sample. Concept of Stratified Sampling, Determining sample size for Simple Random and Stratified Sampling under Equal, Proportional, Neyman's and Optimal allocations. Concept of Systematic sampling, Cluster, Multistage and Probability Proportional to Size (PPS) sampling along with their advantage and disadvantages. Non-probability sampling scheme: Judgment, convenience, quota and accident sampling scheme. Time series analysis: Introduction, Spatial, temporal and conditional series, Objectives of time series, components of time series: Trend, Seasonal, Cyclical and Irregular components. Measurement of trend: Graphical, Semi-Average, Moving Averages and Central Moving Averages, Isolation of trend by moving averages, Ordinary Least Squares (OLS), and fitting of trend. Index numbers: Concept and Definition, objectives of index numbers, advantages and limitations. Prerequisites of index numbers, Types of Index numbers: Price index number (retail and whole sale), Quantity index numbers, Value index numbers. Construction of Simple index numbers under simple aggregative and simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Statistical Quality Control: Definition of control charts, uses of control charts, chance and assignable causes, parts of control charts (central line and control limits). Control charts for variables X-bar and R charts, control charts for fraction defective (p) and control charts for number of defects per unit. Operating characteristic curves for control charts.

Practical

Use of Random Number Tables for selection of Simple Random Sample (WR/WOR). Computing Mean and Variance for Simple random samples. Determining sample size for Simple Random samples. Determining sample size for Stratified Sampling under Equal, Proportional, Neyman's and Optimal allocation. Graphical presentation of various time-series components. Presenting trend line using Graphical and Semi-Average methods. Computation of Moving Average and Central Moving Average, Isolation of trend by moving averages. Fitting of trend line using Ordinary Least Squares (OLS). Construction of Price index number: Retail and Whole sale. Construction of Quantity index numbers and Value index numbers. Construction of Simple index numbers under simple aggregative and simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Construction of Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Construction of X bar and R charts for variables. Construction of fraction defective (p) and number of defects per unit. Construction of Operating characteristic curves for control charts.

Suggested Readings

1. A Textbook of Agril. Statistics. R. Rangaswamy.
2. Advanced Practical Statistics. S.P. Gupta.
3. Fundamentals of Mathematical Statistics. S.C. Gupta and V.K. Kapoor.
4. Introduction to Time Series and Forecasting. Brockwell P.J and Davis RA.
5. Quality Control and Industrial Statistics. John Wiley. Duncan A.J.

6. Sampling Inspection Tables. Dodge H.F. and Romig H.G.
7. Sampling Techniques. Cochran W.G.
8. Statistical Methods in Quality Control. Cowden D.J.
9. Statistical Quality Control. Grant E.L. and Leavenworth R.S.
10. Survey Sampling Theory and Methods. Chaudhari A and Stenger H.
11. Time Series Analysis: Forecasting and Control. Box G.E.P., Jenkins G.M. and Reinsel G.C.

Educational Tour (2 Weeks) **2 (0+2)Non Gradial**

Semester VI

Corporate Social Responsibility and Managerial Ethics **3 (2+1)**

Objectives

1. Understand the concept and significance of corporate social responsibility (CSR) in business
2. Learn about ethical theories and principles guiding managerial decision-making
3. Explore strategies for integrating CSR practices into business operations and stakeholder engagement
4. Develop skills to analyze ethical dilemmas, make responsible decisions, and promote ethical behavior within organizations

Theory

Introduction to Corporate Social Responsibility (CSR): Meaning and Definition of CSR, History and evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR- overlapping concept. Concept of sustainability. Stakeholder Management. CSR through triple bottom line and Sustainable Business; relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India; models of CSR in India, Carroll's model; drivers of CSR; major codes on CSR; Initiatives in India. International framework for corporate social Responsibility, Millennium Development goals, Sustainable development goals, Relationship between CSR and Millennium Development Goals (MDGs). United Nations (UN) Global Compact 2011. UN guiding principles on business and human rights. Organisation for Economic Co-operation and Development (OECD) CSR policy tool, International Labour Organization (ILO) tri-partite declaration of principles on multinational enterprises and social policy. CSR-Legislation in India and the world. Section 135 of Companies Act 2013. Scope for CSR Activities under Schedule VII, Appointment of Independent Directors on the Board, and Computation of Net Profit's Implementing Process in India. The Drivers of CSR in India, Market based pressure and incentives, civil society pressure, the regulatory environment in India. Counter trends. Performance in major business and Programs. Voluntarism Judicial activism. Identifying key stakeholders of CSR and their roles. Role of Public Sector in Corporate, government Program s that encourage voluntary responsible action of corporations. Role of Non-profit and Local Self-Governance in implementing CSR; Contemporary issues in CSR and MDGs. Global Compact Self-Assessment Tool, National Voluntary Guidelines by Govt. of India. Understanding roles and responsibilities of corporate foundations.

Practical

Review of current trends and opportunities in CSR. Review of successful corporate initiatives and challenges of CSR. Analysis and presentation of case Studies of Major CSR Initiatives.

Suggested Readings

1. Bharat's Corporate Social Responsibility by Kamal Garg. Edition 2023
2. Business Ethics and Corporate Social Responsibilities, 1st Edition 2017, by Mathur, SP, Mathur, Nishu, New Age International (P) Ltd. Publishers.
3. Corporate Social Responsibility, Jun 2019, by Andrea Giordani.
4. Corporate Governance Values and Ethics Book for MBA by Dr Neeru Vasishth and Dr Namita Rajput.

Introduction to Managerial Economics 3 (2+1)

Objectives

1. Understand the application of economic principles in managerial decision-making
2. Learn how to analyze market conditions, demand, and cost structures to optimize business strategies
3. Explore the role of managerial economics in pricing, production, and resource allocation within firms
4. Develop skills to make informed decisions that maximize profitability and efficiency in various business contexts

Theory

Managerial Economics: Definition, scope and significance of managerial economics, Basic economic concepts and principles – firm, industry and economy. Demand estimation: Demand forecasting – meaning, importance and techniques. Production analysis: Cobb-Douglas and CES production functions. Modern Firms: Changing objectives of modern firms and their cost curves, Leaning curve, Meaning, uses and types of cost control, revenue concepts and break-even analysis. Monopoly: Monopoly types, characteristics and degrees of price discrimination under monopoly. Monopolistic Competition: Types, characteristics and pricing and output determination, Pricing strategies of modern firms. Macro-economic equilibrium: Money concept, functions, demand for and supply of money. Inflation: Meaning and types of inflation, price indices, causes, effects and control of business cycles using monetary and fiscal policies.

Practica

Computation of different types of demand function. Computation of elasticity of demand -price, income, cross and promotional. Computation of total, average and marginal revenue under different market conditions. Demand estimation through regression analysis. Demand forecasting using non-quantitative and quantitative techniques - trend method, regression method, leading indicator method, simultaneous equations method. Analysis of important demand forecasting methods. Computation of average product, marginal product and elasticity of output with respect to one variable input. Analysis of optimal factor combination using C-D production function.

Computation of elasticity of substitution using C-D and CES production functions. Calculation of optimal output combination of multi-product firms. Derivation of cost functions from production functions and break-even analysis. Determination of market price, market price and normal price. Price determination in perfect competition. Computation of break-even point, learning curve and economies of scope. Calculation of equilibrium price and output under conditions of monopoly and oligopoly. Calculation of market concentration under oligopoly. Price and output determination. Computation of macro-economic equilibrium models.

Suggested Readings

1. Ahuja, H.L. (2008). Managerial Economics – Analysis of Managerial Decision Making. S. Chand and Company Ltd.
2. Chaturvedi, D.D. and S.L. Gupta. (2012). Business Economics Theory and Application. International Book House.
3. Dewett, K.K. 2002. Modern Economic Theory. Syamlal Charitable Trust, New Delhi.
4. Seth, M.L. (2000). Principles of Economics. Lakshmi NarainAgarwal Co., New Delhi.

Marketing Management 3 (3+0)

Objectives

1. Understand the principles and theories of marketing management
2. Learn strategies for product development, pricing, promotion, and distribution
3. Explore market research techniques to understand consumer behavior and preferences
4. Develop skills to create and implement effective marketing plans to achieve organizational objectives

Theory

Marketing– meaning, importance, functions. Marketing Management- definition, difference between marketing and selling. Guiding philosophy of Marketing. Marketing planning: importance, steps, nature. Market Segmentation – meaning, bases and advantages; Market Targeting– Approaches. Positioning – meaning and strategies. Marketing environment analysis. Marketing Mix – 4 Ps and 7 Ps; Product. Product classifications and new product development and launching. Product life cycle – stages; Branding – meaning, selecting a brand, advantages and disadvantages of branding, types of brands; Packaging: meaning, importance, and functions of packaging. Pricing Methods and strategies. Marketing channel–meaning, market intermediaries, types of channels and functions of marketing channel; channel management strategies, channels of distribution, channel management decisions, management of retailing and wholesaling. Direct marketing–methods and advantages and disadvantages; Promotional mix: meaning, elements and objectives. Services Marketing–introduction, meaning, characteristics and Service Marketing Mix.

Suggested Readings

1. Andrew J. Dubrin, 2012, Essentials of Management, Thomson Southwestern, 9th edition.
2. Chabra and Grover, 2012, Marketing Management, Dhanpatrai and Co, New Delhi.
3. Chandrasekar, K.S., 2010, Marketing Management-Text and Cases, Tata McGraw Hill-

Vijaynicole.
4. Charles W.L Hill and Steven L McShane, 2007, Principles of Management, McGraw Hill Education, Special Indian Edition.
5. Harold Koontz and Heinz Weihrich, 2012, Essentials of Management: An International and Leadership Perspective, 9th edition, Tata McGraw-Hill Education
6. Philip Kortler and Kevin Lane Keller, 2012, Marketing Management, PHI 14th Edition.
7. Rajan Sexena, 2005, Marketing Management, Tata McGraw-Hill Education.
8. Samuel C. Certo and Tervis Certo, 2012, Modern Management: Concepts and Skills, Pearson education, 12th edition.
9. Sherlekar, 2013, Marketing Management, Himalaya Publishing House, New Delhi.
10. Sontakki, 2005, Marketing Management, Kalyani Publishers, New Delhi.

Agribusiness Project Management 3 (2+1)

Objectives

1. Understand the principles and practices of project management specific to the agribusiness sector
2. Learn to plan, execute, and monitor agribusiness projects effectively, considering factors such as time, cost, and resources
3. Explore risk assessment and mitigation strategies to ensure successful project outcomes in agricultural settings
4. Develop skills to lead teams, coordinate activities, and communicate effectively to stakeholders in agribusiness projects

Theory

Meaning and definition of project, general features of projects, importance and objectives of project analysis. Categories of projects based on various criteria. Project cycle, stages of project cycle – conception, formulation, appraisal, implementation, monitoring and evaluation. Criteria for appraising projects – ex-ante and ex-post evaluation. Differences between economic and financial analysis in project evaluation. Costs and benefits of agribusiness projects, comparing costs and benefits of agribusiness projects. Externalities – meaning and definition, positive externalities, negative externalities and internalization of externalities, divergence between social costs and benefits of a project. Undiscounted measures of project worth – Accounting Rate of Return (ARR), ranking by inspection, payback period, proceeds per rupee of outlay and average annual proceeds per rupee of outlay. Time value of money - compounding and discounting, choice of discount rate. Discounted cash flow measures of project appraisal – Net Present Worth (NPW), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR). Risk and uncertainty. Sensitivity analysis, general kinds of sensitivity analyses, social cost benefit analysis, and rationale for social cost benefit analysis. Project management– meaning, importance and triple constraint. Project management structures - functional organization, project organization and matrix organization - meaning, advantages and disadvantages. Project Rating Index (PRI), Work Breakdown Structure (WBS) and Responsibility Assignment Matrix (RAM / RACI). Network analysis – CPM and PERT. Project financing - sources of financing a project. Business incubators - definition, types and their benefits. Project control

- monitoring time performance (Gantt Charts, Control Charts), performance index and per cent complete index. Project audit and project closure.

Practical

Generation of agribusiness project ideas, project proposals in agribusiness sector (private and public), exercises on feasibility studies and formulation of detailed project proposals. Investment analysis - undiscounted measures and discounted measures of project worth. Review of case studies pertaining to management of agribusiness projects.

Suggested Readings

1. Austin James .1992. Agro Industrial Project Analysis Critical Factors. John Hopkin University Press, London.
2. Joseph Phillip Hella and Daniel Wilson Ndyetabula. 2012. Agribusiness Project Appraisal: Theory and Applications, Intersperses – Tanzania.
3. Prasanna Chandra, 2014. Projects: Preparation. Appraisal, Budgeting and Implementation, Tata McGraw Hill.
4. Price Gittinger, J. 1982. Economic Analysis of Agricultural Projects. John Hopkins University Press.
5. UNIDO. 1978. Manual for Preparation of Industry Feasibility Studies. United Nations.

Strategic Business Management 3 (2+1)

Objectives

1. Understand the concepts and frameworks of strategic management
2. Learn to analyze internal and external factors influencing business strategy
3. Develop skills to formulate, implement, and evaluate strategic plans to achieve organizational objectives
4. Explore strategies for sustainable growth, competitive advantage, and adaptation to dynamic business environments

Theory

Introduction to Strategies: Introduction, Fundamentals of Strategy, Conceptual Evolution of Strategy, Scope and Importance of Strategies. Strategic Management: Introduction, Need, scope, key features and importance of strategic management. Strategists at various management levels, Types of Strategies, Limitations of Strategic Management. Strategy Analysis and its Importance. The External Environment-The General, Industry, and Competitor Environments-External Environmental Analysis -Scanning–Monitoring-Forecasting–Assessing. Segments of the General Environment-The Demographic Segment-The Economic Segment-The Political/Legal Segment - The Socio cultural Segment - The Technological Segment - The Global Segment-Industry Environment Analysis-Competitor Analysis-Ethical Considerations. The Internal Environment-The Nature of Internal Environmental Analysis -The Context of Internal Analysis-Creating Value -The Challenge of Internal Analysis-Resources, Capabilities, and Core Competencies-Building Core Competencies - Value Chain Analysis –Outsourcing-Competencies, Strengths, Weaknesses, and Strategic Decisions.

Business-Level Strategy -The Purpose of a Business-Level Strategy -Types of Business-Level Strategies -Cost Leadership Strategy -Differentiation Strategy - Focus Strategies -Integrated Cost Leadership/Differentiation Strategy. Competitive Rivalry and Competitive Dynamics-Competitor Analysis-Market Commonality -Resource Similarity -Drivers of Competitive Actions and Responses - strategic and Tactical Actions type of Competitive Action.

Corporate-Level Strategy-Levels of Diversification-Value-Creating Diversification: Related Constrained and Related Linked Diversification -Unrelated Diversification - Value-Neutral Diversification: Incentives and Resources -Value-Reducing Diversification: Managerial Motives to Diversify. Acquisition and Restructuring Strategies -Merger and Acquisition Strategies - Reasons for Acquisitions -Restructuring -Downsizing -Downs coping. International Strategy -Identifying International Opportunities: Incentives to Use an International Strategy-International Business-Level Strategy -International Corporate-Level Strategy-Environmental Trends-Risks in an International Environment -Political Risks -Economic Risks. Cooperative Strategy -Strategic Alliances as a Primary Type of Cooperative Strategy-Business-Level Cooperative Strategy Corporate-Level Cooperative Strategy- International Cooperative Strategy -Network Cooperative.

Practical

Case studies of agribusiness units with respect to their objectives and evaluation of their business strategies, strategic alliances, strategy implementation, implications and challenges.

Suggested Readings

1. Global Strategic Management, 2015 by Jedrzej George Frynas and Kamel Mellahi.
2. Strategic Management: Planning for Domestic and Global Competition, 2018, by John A. Pearce, Richard B. Robinson, and Amita Mital.
3. Strategic Management and Business Policy: Globalization, Innovation and Sustainability, 2018, by Thomas L. Wheelen, J. David Hunger and Alan N. Hoffman.
4. The Secrets of Strategic Management: The Ansoffian Approach, 2006 by Igor H. Ansoff and Peter H. Antoniou.

Rural Marketing 3 (2+1)

Objectives

1. Understand the unique characteristics and challenges of marketing in rural areas
2. Learn strategies for reaching and engaging rural consumers effectively
3. Explore methods for adapting marketing tactics to suit rural market dynamics and preferences
4. Develop skills to identify market opportunities, create tailored marketing campaigns, and enhance rural market penetration for agricultural products and services

Theory

Definition, Scope and Nature of Rural Marketing. Constraints in Rural Marketing and Strategies to Overcome Constraints. Rural Consumer vs. Urban Consumers, Characteristics of Rural Consumers. Rural Market Environment: (a) Demographics; (b) Economic Factors; (c) Rural Infrastructure. Consumer behaviour: meaning and importance, Rural Consumer Behaviour:

Meaning, Factors Affecting Rural Consumer Behaviour – Social Factors, Cultural Factors, Technological Factors, Lifestyle, Personality. Rural marketing strategies: Relevance of Marketing Mix for Rural Market/Consumers. Product Strategies- Rural Product Categories – FMCGs, Consumer Durables, Agriculture Goods and Services; Importance of Branding, Packaging and Labelling. Nature of Competition in Rural Markets, the Problem of Fake Brands. Rural market segmentation – occupational segmentation. Sociological segmentation, Thomson rural Market Index, MICA rural marketing ratings and Lin Quest Data. Pricing Strategies and Objectives, pricing policies - innovative pricing methods for rural markets. Promotional Strategies. Segmentation, Targeting and Positioning for Rural Markets. Distribution Strategies for Rural Consumers: Channels of Distribution- HAATS, Mandis, Public Distribution System, Co-operative Society, Distribution Models of FMCG, Model for Rural Markets (Case Study Based). Communication Strategy: Challenges in Rural Communication, Developing Effective Communication, Determining Communication Objectives, Designing the Message, Selecting the Communication Channels. Creating Advertisements for Rural Audiences. Rural Media – Mass media, Non-conventional Media, Personalized Media. Innovative Distribution Channels like ITC E-choupal, Godrej Adhar, HUL Shakti. Rural Retail Markets: Understanding the rural retail environment, Emergence of modern retail markets in rural areas. Principles of Innovation for Rural Market Need for Innovation in Rural Market, Role of Government and NGOs in Rural Marketing.

Practical

Studying rural marketing environment, Rural Marketing Research, Process of research in Rural Markets, Sources and Methods of Data Collection, Data Collection Approaches in Rural Markets. Corporate Sector in rural marketing, Rural Specific Promotion Media and Methods. Field visits / case studies: Understanding the Rural Market – A Practical Approach Case Studies.

Suggested Readings

1. Acharya S.S. and N.L. Agrawal. Agricultural Marketing in India. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
2. Memoria C.B. and R.L. Joshi. Principles and Practice of Marketing in India. Kitab Mahal, 15, Thorn hill Road, Allahabad.
1. Pradeep Kashyap (2012). Rural Marketing, Published by Dorling Kindersley (India) Pvt. Ltd.
3. Ramtishen, Y. Rural and Agricultural Marketing. VES College of Arts, Science and Commerce, Mumbai. Jacob Publishing House.

Commodity Futures Trading 2 (2+0)

Objectives

1. Understand the fundamentals of commodity futures markets and their role in price discovery and risk management
2. Learn about trading strategies, including hedging and speculation, to manage price volatility
3. Explore the regulatory framework and operational aspects of commodity futures trading
4. Develop skills to analyze market trends, assess risk-reward scenarios, and make informed trading decisions in commodity futures markets

Theory

History and Evolution of commodity markets – Terms and concepts: spot, forward and futures, Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures. Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets. Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features. Important global and Indian commodity exchanges - contracts traded – special features -Regulation of Indian commodity exchanges – SEBI and its role. Fundamental vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

Suggested Readings

1. Acharya, S.S., 1988, Agricultural Production, Marketing and price policy- A study of Pulses, Mittal Publications, Delhi.
2. Jagadish Prasad, 1966, Encyclopedia of Agricultural Marketing, Mittal Publishers Pvt. Limited, Bombay.
3. Kahlon, A.S. and George, M.V., 1965, Agricultural Marketing and Price Policies, Allied Publishers Private Limited, New Delhi.
4. Nayyar, H. and Ramaswamy, P., 1995, Globalization and Agricultural Marketing, Rawat Publications, Jaipur
5. Prasad, A. Shivarama, Agricultural Marketing in India, Mittal Publications, Delhi.
6. Singhal, A.K., 1989, Agricultural Marketing in India, Anmol Publications, New Delhi.

Semester VII

Electives [Student has to choose a minimum of 20 credits from the list of elective courses notified by the University] **20**

ELECTIVE COURSES

(Suggestive, and not Exhaustive List)

1. Agro-Tourism (0+4)
2. Seed Business Management (0+4)
3. Fertilizer Retailing (0+4)
4. Food Retail Business Management (0+4)
5. Supply Chain Management of Agricultural Commodities (0+4)
6. Agri-Export Management (0+4)
7. Hi-Tech Horticulture/Protected Cultivation (0+4)
8. Packaging and Branding of Agricultural Commodities (0+4)
9. e-Commerce in Agribusiness (0+4)

10. Storage and Warehousing of Agricultural Commodities (0+4)
11. Logistics Management of Agricultural Commodities (0+4)
12. Custom Hiring of Agricultural Machinery (0+4)
13. Application of ICT in Agribusiness (0+4)
14. Value Addition to Agricultural Commodities (0+4)
15. Financial Management (0+4)

Note: The Universities/ institutes can offer additional elective courses as per the local needs and facilities available with the respective University.

Agro-tourism 4 (0+4)

Objectives

1. Understand the concept and potential of agro-tourism as a form of rural development
2. Learn about the principles and practices of sustainable agro-tourism operations.
3. Explore strategies for integrating agriculture, tourism, and hospitality to create unique visitor experiences
4. Develop skills to plan, market, and manage agro-tourism enterprises that contribute to local economies and promote cultural exchange

Practical

Agro-tourism: Introduction, importance, scope, forms of agro-tourism, advantages and implementations, introduction to Indian culture. Govt. policies and legislations in respect of tourism and agro-tourism and environment protection laws. Requirements for Agro-tourism. Farm, forest, garden, fish tank/ponds, residential huts, etc. Constraints in operation and management of Agro-tourism activities. Management of resources – Human resources, Natural resources and Garbage management at Agro-tourism centre. Entrepreneurship development: Role and functions, Hospitability: Food and beverages and accommodation services. Communication skill and service; Capital investment, sources and capital budgeting. Project proposal- Preparation and feasibility tests, Accounts and record keeping etc. Marketing strategies for Agro-tourism products and services. Publicity of tourism- Advertisement and use of media.

Suggested Readings

1. Agritourism, by M. Sznajder, L. Przezbórska and F. Scrimgeour.
2. Agrotourism Management: A Complete Practical Guide, 2020, by S. G. Walke, Atul Kumar and Vinaydeep Brar.
3. The New Agritourism, January 2008, by Barbara Berst Adams.

Seed Business Management 4 (0+4)

Objectives

1. Understand the principles of seed business management, including production, marketing, and distribution
2. Learn strategies for quality control, seed certification, and regulatory compliance in seed industry operations

3. Explore market analysis and branding techniques to enhance seed sales and market share
4. Develop skills to develop and implement business plans that ensure profitability and sustainability in the seed industry

Practical

Seed Technology – Role of Seed Technology, Seed Industry in India, National Seed Corporation, State Seed Corporations, National Seed Project and State Farms and their role. Development and Management of Seed Program s – Seed Village Concept, Basic Strategy of Seed Production and Planning and Organization of Seed Program; Types of Seed Program – Nucleus seed, Breeders seed, Foundation seed and Certified seed etc. Maintenance of genetic purity – Minimum seed certification standard and Management of breeders and Nucleus seed; Management of seed testing laboratory and research and development. Management of seed processing plant, seed storage management; seed packaging and handling. Seed Marketing; GM Crop seed, IPR, PBR, Patents and related issues and their impact on developing countries; Statutory intervention in the seed industry; Seed legislation and seed law enforcement, Seed act; Orientation and visit to seed production farms, seed processing Units, NSC, SSC and seed testing laboratories.

Suggested Readings

1. Agricultural Marketing in India, 2021, by S.S. Acharya and N.L. Agarwal.
2. Seed Technology and Management, 2021, by Dr. Bilal Ahmad Wani.
3. Seed Technology Processing Storage and Marketing by Kanwar H S *et al.*, Jain Brothers.
4. Vegetable Hybrid Seed Production and Management, 2010, by K. Vanangamudi.

Fertilizer Retailing 4 (0+4)

Objectives

1. Understand the principles of fertilizer retailing, including product knowledge, sales techniques, and customer service
2. Learn about inventory management, pricing strategies, and distribution logistics in fertilizer retail operations
3. Explore marketing strategies to attract and retain customers, including promotions and loyalty programs
4. Develop skills to effectively manage fertilizer retailing operations, optimize sales, and maximize profitability while meeting regulatory requirements and ensuring environmental stewardship

Practical

Fertilizer development – concept, scope, need, resource availability; import and export avenues for fertilizer; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India. Raw material needed and principles of manufacturing of nitrogenous, phosphatic and potassic fertilizers, secondary nutrient sources and micronutrient formulations. Production efficiency and capacity utilization; quality control and legal aspects- fertilizer control order. Testing facilities; constraints in fertilizer use and emerging scenario

of fertilizer use; assessment of demand and supply of different fertilizers, fertilizer distribution, fertilizer storage. Field trials and demonstration, fertilizer pricing policy; scope of biofertilizer; environmental pollution due to fertilizer use.

Suggested Readings

1. Growing Gardens, Building Power: Food Justice and Urban Agriculture (Nature, Society, and Culture), 2022, by Justin Sean Myers.
2. Retailing Management | 9th Edition, 2021, by Michael Levy, Barton Weitz and Dhruv Grewal.
3. Soil Fertility and Fertilizers: An Introduction to Nutrient Management, 2016, by Kindly Edition
4. The Retail Start-Up Book: Successfully Plan, Launch and Grow a Business, 2022, by Rowland Gee, Danny Sloan and Graham Symes.

Food Retail Business Management 4 (0+4)

Objectives

1. Understand the principles of food retail management, including product assortment, merchandising, and customer service
2. Learn about inventory management, supply chain logistics, and pricing strategies in food retail operations
3. Explore marketing techniques to attract and retain customers, including promotions, branding, and store layout optimization
4. Develop skills to effectively manage food retail businesses, ensure food safety, and meet consumer demands in a competitive market environment

Practical

Introduction to International Food market, India's Competitive Position in World Food Trade, Foreign Investment in Global Food Industry, Retail management and Food Retailing, The Nature of Change in Retailing, Organized Retailing in India, E-tailing and Understanding Food Preference of Indian Consumer, Food Consumption and Expenditure pattern, Demographic and Psychographic Factors Affecting Food Pattern of Indian Consumer. Value Chain in Food Retailing, Principal trends in food wholesaling and retailing, food wholesaling, food retailing, the changing nature of food stores, various retailing formats, competition and pricing in food retailing, market implications of new retail developments, value chain and value additions across the chain in food retail, food service marketing. 4 P's in Food Retail Management, Brand Management in Retailing, Merchandise pricing, Pricing Strategies used in conventional and non-conventional food retailing, Public distribution system, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers. Managing Retail Operations, Managing Retailers' Finances, Merchandise buying and handling, Merchandise Pricing, Logistics, procurement of Food products and Handling Transportation of Food Products. Retail Sales Management Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing, Legal and Ethical issues in Retailing.

Suggested Readings

1. Berman, B. and Evans, J.R. 2009. Retail management. Pearson Education, New Delhi, 343p.
2. CII Global Retail Report, Confederation of Indian Industry, New Delhi.
3. Hasty, R. and Reardon, R.1997. Retail management. McGraw Hills Education, New Delhi, 339p.
4. Journal of Retailing. Elsevier, Netherlands.
5. Singh, H. 2014. Retail Management: A global perspective: Text and Cases. S. Chand and Co Ltd, New Delhi, 871p.
6. Journal of Business and Retail Management Research, Academy of Business and Retail Management, UK.

Supply Chain Management of Agricultural Commodities 4 (0+4)

Objectives

1. Understand the principles and practices of supply chain management specific to agricultural commodities
2. Learn to optimize the flow of agricultural products from farm to consumer, including procurement, transportation, and distribution
3. Explore strategies for inventory management, storage, and quality control to minimize waste and ensure product integrity
4. Develop skills to coordinate and integrate activities along the agricultural supply chain to enhance efficiency, reduce costs, and meet customer demands

Practical

Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM. Demand Management in Supply Chain: Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management. Procurement Management in Agri. Supply chain: Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory Logistics Management: History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology. Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management- Benchmarking: introduction, concept and forms of Benchmarking.

Suggested Readings

1. Groznik, A. and Xiong, Y. 2014. Pathways to Supply Chain Excellence. CC BY Intech Publishers, USA, 342p.

2. Kaplinsky, R. and Morris, M. 2014. A Handbook for Value Chain Analysis. IDRC, UK, 217p.
3. Miller, C. and Jones, L.M. 2010. Agricultural Value Chain Finance: Tools and Lessons Food and Agriculture Organization of United Organizations, Italy, 321p.
4. Springer, H.A. 2007. Value links: The methodology of value chain promotion. GIZ LRED, South Africa, 290p.
5. Vermeulen, S., Woodhill, J., Proctor, F. and Delnoye, R. 2014. Chain-wide learning for inclusive agri-food market development. IIED, 398p.

Agri-Export Management 4 (0+4)

Objectives

1. Understand the principles and practices of exporting agricultural products
2. Learn about international trade regulations, documentation, and logistics specific to agri-exports
3. Explore market analysis and market entry strategies to identify and capitalize on export opportunities
4. Develop skills to manage export operations effectively, negotiate contracts, and navigate global markets to maximize returns for agricultural products

Practical

International Trade - meaning, definition, nature and scope. Salient features of international trade, differences between internal trade and international trade, advantages and disadvantages of international trade.

Theories of international trade - mercantilism, theory of absolute cost advantage, theory of comparative cost advantage and modern theory of international trade. Terms of trade - meaning and types. Free trade - meaning, advantages and disadvantages, free trade agreements.

Protectionism - meaning, advantages and disadvantages of protectionism, types of protection - tariffs, quotas, subsidies, dumping, cartels and commodity agreements. Balance of Trade (BoT) and Balance of Payments (BoP) - meaning, differences between BoT and BoP, India's BoT and BoP position. Foreign exchange – meaning, foreign exchange rate, types of foreign exchange rate, mechanisms of determining foreign exchange rate. Foreign exchange market – meaning and functions, instruments of international payments, foreign exchange control and foreign exchange reserves.

WTO – origin, structure, objectives and functions. Agreement on Agriculture - domestic support, market access and export subsidies. FAO / WHO Codex Alimentarious and SPS measures.

Export procedures and documentations, types of export - direct export and indirect export, export houses – objectives and types. Agricultural export promotion organizations - APEDA, MPEDA, Commodity Boards and State Export Promoting Agencies. India's agricultural exports and imports – composition and trading countries. India's foreign trade policy – meaning and objectives.

Suggested Readings

- Agricultural Exports of India, by Priya Kumari.
- Export Import Management, 2nd edn by Justin Paul and Rajiv Aserkar, Oxford.
- Innovations in Agri-Business Management, 2009, by Karnam Lokanadhan.
- Management of Agribusiness and Agri Exports ,2022, by Rupali Bipin Sheth, Nutan Thoke and Asmita V. Kulkarni.

Hi-Tech Horticulture / Protected Cultivation 4 (0+4)

Objectives

- Understand the principles and techniques of hi-tech horticulture, including protected cultivation methods
- Learn about advanced technologies such as greenhouse and hydroponic systems for optimized crop production
- Explore strategies for climate control, irrigation, and nutrient management to maximize yield and quality in protected cultivation
- Develop skills to implement and manage hi-tech horticulture practices for sustainable and profitable crop production

Practical

Introduction, importance and scope of hi-tech horticulture in India, Hi-tech nursery management and mechanization of horticultural crops, Micropropagation of horticultural crops, Hi-tech field preparation and planting methods, Protected cultivation: Advantage and constraints, Environmental control in green house- temperature, light, CO_2, relative humidity and ventilation methods and techniques, Micro irrigation systems and its components, EC/pH based irrigation/ fertigation scheduling, Hi-tech canopy management of horticultural crops, High density orcharding in Mango, guava, papaya, citrus, pineapple etc, Remote sensing and geographical information system, Differential geo-positioning system (DGPS), Component of precision farming and application of precision farming in horticultural crops (fruit, vegetables and ornamental crops 2 crops each), Mechanized harvesting produce, Post harvest management for export

Suggested Readings

1. Hi Tech Horticulture (Pb) by Prasad and S Et Al, Agrobios
2. Protected Cultivation by Pradhan, Adikant, Satish Serial Publishing House
3. Protected Cultivation of Horticulture Crops by Prabhakar, Itigi
4. Textbook of Protected Cultivation and Precision Farming For Horticultural Crops by Kumar, B Ashok et al, Jain Brothers

Packaging and Branding of Agricultural Commodities 4 (0+4)

Objectives

1. Understand the importance of packaging and branding in enhancing the marketability of agricultural commodities

2. Learn about effective packaging materials, designs, and techniques for preserving product quality and attracting consumers
3. Explore branding strategies to differentiate agricultural products, build brand equity, and create value for consumers
4. Develop skills to design, implement, and evaluate packaging and branding strategies that meet market demands and enhance competitiveness in the agricultural sector

Practical

Customer: How to Identify Customer Needs, How to Make Product Development as per the Customer need, Recent Trends in Marketing, Target Customer (Definition and general Info), Psychographics (lifestyle, Hobbies, behavior pattern), Demographics (Age, Education, gender.), Consumer segmentation.

Food Processing: What is Food Processing. Processing stages for Various products, Methods of Food Preservation

Food Packaging: Introduction to food packaging and opportunities for start-ups, Food packaging materials: (Paper, metal, glass, plastics and cardboard), Food Packaging: an important tool for nutrition, safety and effective marketing, Food Packaging Machinery, Selection Criteria for Food Packaging system, Types of Packaging, Advances in food packaging (or A peep into the future of food packaging).

Branding: What is Brand? Communication platform between customer and product, What are their characteristics? Why does the product need branding? How does branding help? What are the drivers? Branding ideas (case studies).

How To Promote Branding: How to get prominence? Visual Merchandising, Retail Merchandising, How does the Branding category help?

Suggested Readings

1. Agricultural Marketing in India by S.S. Acharya and N.L. Agarwal, 202.1
2. Cultures of Commodity Branding (UCL Institute of Archaeology Publications) by Andrew Bevan and David Wengrow, 2016 Kindle Edition.
3. From Commodity To Experience - Why Semiconductor Branding Is Important Now? by A Singh, 2011.
4. Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities, by Elhadi M. Yahia, 2009.

e-Commerce in Agribusiness 4 (0+4)

Objectives

1. Understand the principles and dynamics of e-commerce within the context of agribusiness
2. Learn about e-commerce platforms, technologies, and strategies for marketing and selling agricultural products online
3. Explore the benefits and challenges of e-commerce adoption in agribusiness, including logistics, payment systems, and customer engagement

4. Develop skills to leverage e-commerce opportunities to reach wider markets, increase sales, and improve efficiency in agricultural trade

Theory

Introduction- meaning and forces behind E-commerce, industry framework, brief history of E-commerce, advantages of E-commerce, Inter-organizational E-commerce, Intra organizational E-commerce, Pure v/s Partial E-commerce. Network infrastructure for E-commerce, the internet, intranets and extranets as E-commerce infrastructure. Encryption- WWW and security encryption, transaction security, secret key encryption, public key encryption, virtual private network, implementation management issues; Electronic payments- overview of E-payments, digital token based electronic payment system, smart cards, credit cards / debit cards based electronic payment system, emerging financial instruments, home banking and online banking. Electronic Data Interchange (EDI), Development of EDI, Application of EDI in business, legal requirements in E-commerce. Introduction of Ecommerce in supply chain management (SCM) and customer relationship management (CRM). E-commerce standards- Introduction, types of standards, document translation standards. E-commerce law- introduction, E-commerce transaction, electronic fund transaction act and regulation, forms of agreement, legal issues in Indian scenario. Mobile commerce introduction to M-commerce, mobile computing application s, wireless application protocols, WAP technology. Web Security- Introduction to web security, firewalls and transaction security, client server network, emerging client server security threats, firewalls and network security.

Practical

E-commerce- case studies of which include six success stories like India times. com, Rediff. com, Baazee. com, SAIL, ITC- E-choupal, AMUL, Digital Marketing- Introduction, the effects of E-business technologies on marketing strategy, First generation marketing tools- Email marketing, online marketing, search marketing, affiliate marketing. Second generation digital marketing tools and viral marketing, Future challenges and opportunities of E-commerce.

Suggested Readings

1. Agribusiness Management Theory and Practices by Dr Shoji Lal Bairwa and Dr Ch and ra Sen and Dr L K Meena and Dr Meera Kumari, Write and Print Publications
2. Agribusiness Management, January 2019, by Biswas and Giri Mishra, Himalaya Books Pvt. Ltd.
3. Books from same Author: Dr Shoji Lal Bairwa and Dr Ch and ra Sen and Dr L K Meena and Dr Meera Kumar
4. E-Commerce Business: The Essential Guide to E-Commerce Success, Learn All the Valuable Information You Need in Starting a Successful E-Commerce Business S.P. Suarker, Oct 2020 · Author's Republic. Narrated by Marcus Mulenga

Storage and Warehousing of Agricultural Commodities 4 (0+4)

Objectives

1. Understand the principles of storage and warehousing for agricultural commodities

2. Learn about storage techniques, facilities, and equipment used to maintain product quality and minimize losses
3. Explore strategies for inventory management, handling, and distribution to optimize storage efficiency and reduce post-harvest losses
4. Develop skills to design, manage, and operate storage and warehousing facilities effectively to ensure the availability of high-quality agricultural commodities for market

Practical

Distribution management - storage and warehousing and transportation management for agricultural products; marketing agencies/intermediaries – roles and functions; distribution channels involved in agribusiness.

Suggested Reading

1. Agricultural Marketing in India by S.S. Acharya and N.L. Agarwal, 2021.
2. Emerging Trends in Agricultural Marketing in India by Ashok M. V, 2021.
3. Groznik, A. and Xiong, Y. 2014.Pathways to Supply Chain Excellence.CC BY Intech Publishers, USA,342 p.
4. Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities, by Elhadi M. Yahia, 2019.

Logistics Management of Agricultural Commodities 4 (0+4)

Objectives

1. Understand the principles of logistics management as applied to agricultural commodities
2. Learn about transportation, inventory management, and supply chain optimization techniques specific to agricultural logistics
3. Explore strategies for efficient handling, storage, and distribution of agricultural products to minimize costs and maximize value
4. Develop skills to plan, coordinate, and execute logistics operations effectively to ensure timely delivery and quality preservation of agricultural commodities

Practical

Introduction to physical distribution, Logistics management, Logistics Management and its elements, Modern Concepts in Logistics, Role of logistics in strategy, Inbound and outbound supply chain management, Container – types, Different types of cargo, Packaging and Material Handling, Introduction to supply Chain Management (SCM), Sourcing, Transportation, Indian supply chain architecture, Introduction to warehousing, Warehouse functions, Warehouse types, Warehouse providing value added services, Warehouse internal operations, Warehousing equipment, Inventory, Safety and security in warehouses, Future trends in warehousing, Introduction – recent developments in logistics, Transport and mobility technologies, Green logistics, Cold chain logistics, Block chain and big data analytics in logistics, 3 D printing and wearable devices in logistics, Transport Services, Costing and Performance, Administration and Control and use of IT.

Suggested Readings

1. Ballou, R.H. and Samir, K. 2012. Business logistics/Supply chain management. Pearson Education, New Delhi, 429p.
2. Groznik, A. and Xiong, Y. 2014.Pathways to Supply Chain Excellence. CC BY Intech Publishers, USA,342p.
3. Kaplinsky, R. and Morris, M. 2014.A Handbook for Value Chain Analysis. IDRC, UK, 217p.
4. Miller, C. and Jones, L. M. 2010. Agricultural Value Chain Finance: Tools and Lessons Food and Agriculture Organization of United Organizations, Italy,321p.
5. Springer, H. A. 2007. Value links: The methodology of value chain promotion. GIZ LRED, South Africa, 290p.
6. Vermeulen, S., Woodhill, J., and Proctor, F., and Delnoye, R.2014. Chain-wide learning for inclusive agri-food market development. IIED, 398p.

Custom Hiring of Agricultural Machinery 4 (0+4)

Objectives

1. Understand the principles and benefits of custom hiring services for agricultural machinery
2. Learn about the management and operation of custom hiring centers for efficient machinery utilization
3. Explore strategies for providing cost-effective machinery services to smallholder farmers and agricultural communities
4. Develop skills to assess demand, set pricing, and manage logistics effectively in custom hiring operations to support sustainable agricultural practices

Practical

Understand general discipline in the class room and workshop (Do's and Don'ts) Study the scope and importance of Farm Mechanization industry in India Familiarize with different farm machineries' manufacturers and their brands/models Understand the role of a Custom Hiring Service Provider and the progression pathways State the importance of entrepreneurship Select entrepreneurship as an alternate career option State customer hiring centre meaning and its role in promotion Explain the differences between entrepreneurship, self employment and wage employment Discuss case studies, video presentation, group discussion, debates and exercise in entrepreneurship activities Discuss and interact with successful entrepreneurs and business people in a similar field to gain expertise State the role and reward of entrepreneurship Explain the need and importance of market assessment List components and techniques of market survey/ assessment Explain demand analysis and assessment of farmers needs Identify possible sources of finance/loan Identify potential customers and maintain customer database Conduct target market assessment and decide positioning of products/ services which is easily accessible to potential buyers List criteria for selection of location for conducting business Understand government laws, local state laws and other regulations for business activity Identify distribution and marketing channels considering the requirements and constraints associated with the same Estimate costing and pricing Calculate risk assessment in business Identify opportunities for scaling up the business Collect information related to various subsidies/funds/ schemes offered by the government, authorized state units and other financial institutions Track and maintain records, and monitor them on a regular

basis Explain promotional strategies for the business based on the budget and target segment State minimizing costs and maximizing profits steps Select the machineries for Custom Hiring Centre.

Suggested Readings

1. Review of and recommendations for custom hiring centers for mechanization in Nepal and the Asian region: 2021, by Food and Agriculture Organization
2. Testing, Evaluation of Agricultural Machinery, Equipment, by Smith, 2020
3. Testing and Evaluation of Agricultural Machinery 2nd Revised and Enlarged Edn by M L Mehta
4. Unit Operations of Agricultural Processing by K.M. Sahay and K.K Singh, 2004

Application of ICT in Agribusiness 4 (0+4)

Objectives

1. Understand the role and importance of Information and Communication Technology (ICT) in agribusiness
2. Learn about various ICT tools and applications for farm management, market analysis, and supply chain optimization
3. Explore strategies to leverage ICT to enhance productivity, efficiency, and competitiveness in agribusiness operations
4. Develop skills to implement and integrate ICT solutions effectively to address challenges and capitalize on opportunities in the agricultural sector

Practical

Introduction and scope of ICT in Agriculture, Need for ICT in Agricultural Extension. National Policies on ICT in Agricultural Extension. Role of communications in ICT: Concept, elements and their characteristics. Message: meaning, dimensions of a message characteristics of a good message, message treatment and effectiveness, distortion of message. Methods of communication: meaning and function. Forms of communication. Role of Mass Media in dissemination of farm technology. Modern communication media: electronic video, tele text, tele conference, computer assisted instruction. Telephone/Mobile Technology: Farmer Call Centre, SMS Broadcast Service, m-krishi. ICT initiatives of NGOs and Private Companies. ICT initiatives by ICAR and SAUs, Value Added Services, Fisher Friend Project, SMS Services to farmers by Department of Agriculture. Practices of ICT for Agricultural Extension: aAQUA, Digital Green, e-Agrik (e-Agriculture), e- Sagu (e-cultivation), KISSAN (Karshaka Information Systems Service and Networking), Solutions through Information, VASAT-Virtual Academy for the Semi-Arid Tropics, Touch Screen Kiosk, e-Extension (e-Soil Health Card Program). Village Knowledge Centre (VRC/VRC/CIC): Introduction, concept, process for setting VRC. Warana Wired Village Project, Web Portals: AGRISNET, DACNET, InDG, DEAL, i-KISAN, e- Krishi, ASHA, IFFCO- Agri-Portal, Agriwatch Portal, i-Shakti. ICTs for market information and Agri-Business: AGMARKNET, e-KRISHI VIPNAN, ICT-e-CHOPAL, EID Garry-Indiagriline.

Suggested Readings

1. Agribusiness and Technology: Revolutionizing the Future of Farming by Sujit Sahgal, 2021.
2. Agriculture 5.0: Artificial Intelligence, IoT and Machine Learning by Latief Ahmad and Firasath Nabi, 2021.

3. Drones and Geographical Information Technologies in Agroecology and Organic Farming: Contributions to Technological Sovereignty, by Alberto Diantini, Massimo De Marchi, et al., 2022.
4. Educational Technology and ICT by Dr. A.B. Bhatanagar and Dr. Anurag Bhatnagar, 2016,

Value Addition to Agricultural Commodities 4 (0+4)

Objectives

1. Understand the importance of value addition in increasing the market value of agricultural commodities
2. Learn techniques for processing, packaging, and branding to enhance the quality and appeal of agricultural products
3. Explore strategies to diversify product lines and create new revenue streams through value-added products
4. Develop skills to identify value addition opportunities, optimize production processes, and meet consumer preferences for higher-quality agricultural commodities

Practica

Food processing and value addition basics, Hygiene and sanitation in food processing Standards for food processing, Sorting and grading of fruits and vegetables, Preparation of fruits and vegetables for processing, Production of fruit marmalade (jam), Production of peanut flour and peanut butter, Solar drying of fruits and vegetables, Milk value addition, Mushroom production, Packaging and packaging material, Branding and labelling.

Suggested Readings

1. A Comprehensive Manual for Food Technology and Agricultural Value Addition, by Stephen Wachira Kariuki | 13 April 2021.
2. Agricultural Marketing in India by S.S. Acharya and N.L. Agarwal, 2021.
3. Composting Agricultural Residues for Value Addition, by Seema Garcha, 25 July 2010.
4. Postharvest, Value Addition and Export: Agricultural Commodity Export and Processing by Adeniyi Oyegbile, 4 September 2022.

Financial Management 4 (0+4)

Objectives

1. Understand the principles of financial management and its importance in business
2. Learn how to analyze financial statements, manage budgets, and make investment decisions
3. Explore strategies for financing operations, managing cash flow, and mitigating financial risks
4. Develop skills to optimize financial performance, enhance profitability, and ensure long-term sustainability in business operations

Practical

Estimation of project cash flows, Evaluation of proposals. Evaluation techniques- Discounting and non-discounting techniques. Risk analysis in capital budgeting. Estimation of working capital requirements; Inventory Management; Appraisal of project proposals using capital budgeting

techniques. Computation of costs of borrowed capital, preferred stock, equity capital and retained earnings. Calculation of Operating Leverage, Financial Leverage and Combined Leverage. Valuation of stocks and debentures. Estimation of operating cycle.

Suggested Readings

1. Khan and Jain 2014., Financial Management, Tata McGraw Hill.
2. Pandey, I.M., 2010. Financial Management (10th edn), Vikas Publishing House (P) Ltd, New Delhi.
3. Ravi M.K. 2015. Financial Management: Theory, Problems, Cases. Taxman Publications Prentice Hall of India Learning (8th edn).
4. Sharma, R. K., and Sasi Guptha K., Management Accounting, Kalyani Publishers.
5. Vyaptakesh, S. 2012. Fundamentals of Financial Management, Pearson Publishers.

Semester VIII

Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/ Internship/ Attachment to Rand D Institute/ Laboratory, etc.] **20 Credit**

SKILL ENHANCEMENT COURSES

(Indicative list)

SEC-1: Computer Applications in Agriculture

SEC-2: Production Technology for Bio-Agents and Bio-fertilizers

SEC-3: Seed Production and Seed Testing

SEC-4: Livestock Production and Management

SEC-5: Poultry Production Technology

SEC-6: Development of Agribusiness Proposal

ONLINE COURSES

The student will be free to choose minimum 10 online credit courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons.) Agribusiness Management.

- These can be related to Basic Sciences/ Humanities/ Language/ Communication skills, etc. available on MOOCS/ SWAYAM or any other portal.
- These courses can be taken any time during the degree program as per the choice of the students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered with the consent of the concerned Dean of the College. The final transcript will indicate the title of courses taken by the student and the duration of such courses.

Course Curricula for Undergraduate Program in Natural Farming

UG-Certificate (Natural Farming) UG-Diploma (Natural Farming) B.Sc. Ag. (Hons.) Natural Farming

INTRODUCTION

Agrological practices are gaining importance across the globe aiming to address the issues in agriculture especially for achieving the sustainability without affecting the ecosystems. In this endeavour, Government of India is focusing on various alternate options to make agriculture self-sustainable. Natural farming is one such avocation and it is gaining importance among the farmers. However, well trained human resource is essential to promote natural farming. Considering the above, ICAR constituted a committee to develop curricula for Undergraduate and Postgraduate Degree programs in Natural Farming. Subsequently, a Sub-committee was constituted for realignment and restructuring of syllabus for UG Degree on Natural Farming as per NEP-2020 and Sixth Deans" Committee framework.

Development and restructuring of undergraduate program in Natural Farming has been done as per NEP guidelines to build strong foundation of knowledge among students with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge.

This curriculum framework puts down the appropriate curricular goals, content, pedagogical approaches and also specifies the allocation of time for different curricular activities that is proportional to the intended learning outcomes.

The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farmland ecosystem and reducing the market inputs. These important aspects of natural farming are considered as cost- effective and suitable for livelihood of large number of farmers and sustainable rural development.

The restructured course curriculum aims at strengthening critical thinking, creativity, communication and collaboration among the students. An immersion- cum-foundation program of three weeks is included at the start of the course which is aimed at instilling life

and social skills, social awareness, ethics and values, knowing and being, team work, leadership, creativity, etc. More emphasis has been given on skill enhancement courses, experiential learning, projects, industry attachments, flexibility in choice of courses via electives and also through online courses.

Provision has also been made for advanced skill enhancement through project work or experiential learning/ incubation, etc. Through such activities, more emphasis has been given on conceptual learning than rote learning as well as for inculcating ingenuity and critical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

The details of the semester- wise course structure for the Undergraduate Courses in Natural Farming (UG-Certificate, UG-Diploma and B.Sc. Ag. (Hons.)) Natural Farming have been prepared after having multistage in-depth deliberations and discussions through virtual meetings and personal communications with the members of committee It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of Atmanirbhar Bharat.

HIGHLIGHTS

- The whole course program of B.Sc. Ag (Hons.) Natural Farming is of 166+10* (*NC-MOOC) = 176 credit hours. The minimum eligibility requirement for admission in undergraduate program on Natural Farming will be the same as in case of B.Sc. Agriculture (Hons.). After the admission of students in the university, the students will register for the Foundation Course of 3 weeks duration in the 1st semester. The course will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, knowing and being, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures), diverse potentialities will be taken into account and cultural integration of students from different backgrounds will be encouraged. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated for knowledge and skill enhancement in Natural Farming including Indian heritage and applied aspects of natural farming. After satisfactory completion of 40 credits of courses in two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Natural Farming on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The skill program during the first year is termed as Skill Enhancement Courses (SEC). The students will have flexibility and choice in selection of skill development area from a basket of SEC modules to be offered by the parent institute. After one- week common orientation on different skill enhancement modules, students will take up either one or more modules (maximum 4) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles

of the proposed modules.

- An institution (University or College) is at liberty, and in fact it should work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running various SEC programs. In such cases, while the parent institution will control admission process, develop the content and delivery of the program and monitor the learning and skill development by students and the evaluation can be done jointly by the collaborating partners.
- The second year has been designed with the practical exposure on natural farming as well as some part of fundamental courses related to agricultural sciences with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of natural farming. After satisfactory completion of the courses of 2nd year and subsequent completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Natural Farming on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- The third year and fourth year courses have been designed to impart in depth details including specialized knowledge to the students in the major disciplines. In order to inculcate the moral and experiential habits in students to, research methodology and ethics were also added besides Student READY (Rural and Entrepreneurship Awareness Development yojana) include Rural Agricultural Work Experience program/experiential learning/internship and student projects.
- There will be adequate choice of electives/ specialized courses for the students in the final year. The Universities will have flexibility to include more courses as electives depending on specific needs. The objective is to enable the student to acquire deeper understanding in any particular field. As regards individual course contents, universities/colleges may modify the content to the extent of 20 percent whenever necessary as per the regional demands and needs. There will be choice of elective/ specialization in final year for students.
- Students will also be given freedom to opt 20 credits of non-credit courses from MOOC or any other portal in on line mode to groom up her/his passion and add on the knowledge components based on her/ his choice. There will also be flexibility to complete these non-credit elective courses of 20 credits throughout the span of the degree program.
- The online courses can be from any field such as Agriculture, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including Foreign Languages, Communication Skills/ Music, etc. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- In eighth semester of the degree Program, students will be offered 20 credits from Student READY Programs including RAWE/Project work/industrial attachment experiential learning, internship or any other option mentioned by the parent institute. The project work may be Natural Farming-based project/research based project or Industry based project depending on the interest of the students.

Entry and Exit Options

The entry and exit options for the UG Program in Natural Farming are shown in the figure 1.

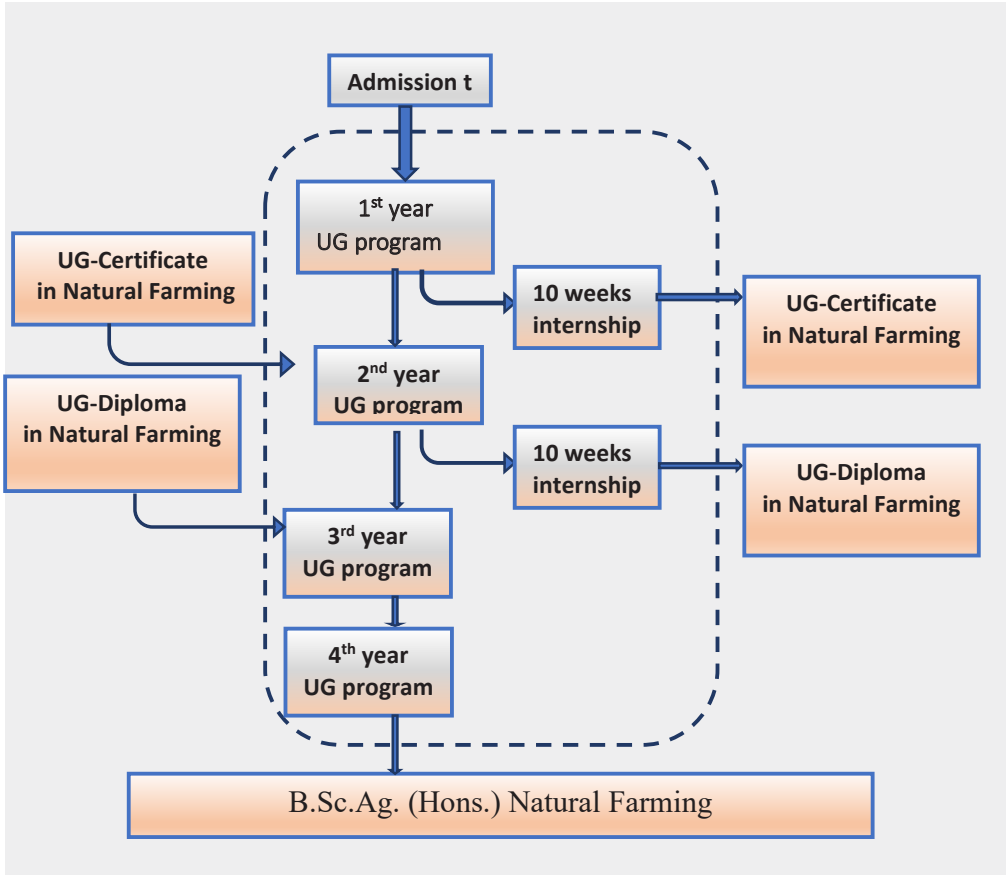

Fig 1. Entry and Exit Option in B.Sc.Ag. (Hons.) Natural Farming

Exit options

UG-Certificate in Natural Farming (exit after first year and completion of 10 weeks' internship)

UG-Diploma in Natural Farming (exit after second year and completion of 10 weeks' internship)

B. Sc. Ag. (Hons.) Natural Farming (on successful completion of four-year degree requirements)

The Universities may also consider allowing lateral entry for the candidates having Diploma in Natural Farming from Polytechnic colleges or other institutions approved by UGC/ICAR at the State and National level program) may be allowed admission into the 3rd year of the UG program, following the norms of lateral entry in respective universities/ institutions.

Admission

The minimum eligibility requirement for admission in undergraduate program on Natural Farming will be the same as in case of B.Sc. (Hons.) Agriculture.

Academic Program

Semester Wise Course Distribution

1st Year

Semester I

S. No	Course Title	Credit Hours	Total Credits
1.	Deeksharambh (Induction cum Foundation course)	2 (0+2)NG	21(10+11)
2.	Indian Heritage of Natural Farming	3 (2+1)	
3.	Principles and Practices of Natural Farming	4 (3+1)	
4.	Bhumi Suposhan (Soil Nutrition)	3 (2+1)	
5.	Farming based Livelihood System	3 (2+1)	
6.	Communication Skills	2 (1+1)	
7.	Skill Enhancement Course (SEC-I)	2 (0+2)	
8.	Skill Enhancement Course (SEC-II)	2 (0+2)	
9.	NCC-I/NSS-I	1 (0+1)	
10.	Physical Education, First Aid and yoga Practice	1 (0+1)	

Semester II

S. No	Course Title	Credit Hours	Total Credits
1.	Cow- based Natural Farming	3 (1+2)	21 (9+12)
2.	Soil Biology in Natural Farming	3 (2+1)	
3.	Integration of Horticulture Crops under Natural Farming	2 (1+1)	
4.	Insect Ecology, Nematodes and Pest Management	3 (2+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Personality Development	2 (1+1)	
7.	Skill Enhancement Course (SEC-III)	2 (0+2)	
8.	Skill Enhancement Course (SEC-IV)	2 (0+2)	
9.	NCC-II/NSS-II	1 (0+1)	

2nd Year

Semester III

S. No	Course Title	Credit Hours	Total Credits
1.	Crop Management in Natural Farming	3 (2+1)	21 (11+10)
2.	Production of Bio-inputs	2 (1+1)	
3.	Farm Power and Machinery	3 (1+2)	
4.	Livestock and Poultry Production	3 (2+1)	
5.	Management of Plant Diseases	2 (1+1)	
6.	Biodiversity Conservation	2 (1+1)	
7.	Physical Education, First Aid and Yoga Practice	1 (0+1)	
8.	Skill Enhancement Course (SEC-V)	2 (0+2)	
9.	Environmental Studies and Disaster Management	3 (2+1)	

Semester IV

S. No	Course Title	Credit Hours	Total Credits
1.	Elements, Characteristics and Design of Natural Farming Systems	3 (2+1)	**22 (13+9)**
2.	Improvement of Traditional and Under-Utilized Crops	3 (2+1)	
3.	Agro-Ecosystem Analysis for Natural Farming	2 (1+1)	
4.	Beneficial Insects	3 (2+1)	
5.	Quantification and Valuation of Ecosystem Services	3 (2+1)	
6.	Agricultural Marketing and Trade	3 (2+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Skill Enhancement Course (SEC-VI)	2 (0+2)	

Semester V

S. No	Course Title	Credit Hours	Total Credits
1.	Post-Harvest Management –I	3 (2+1)	**20 (12+8)**
2.	Bio- resources and Agricultural Waste Management	3 (2+1)	
3.	Medicinal and Aromatic Plants	2 (1+1)	
4.	Seed Production Technology	3 (2+1)	
5.	Value Chain Management in Natural Farming	2 (1+1)	
6.	Renewable Energy Sources	2 (1+1)	
7.	Natural Farming and Human Health	2 (1+1)	
8.	Fundamentals of Entomology	3 (2+1)	
9.	Educational Tour	CNC	

Semester VI

S. No	Course Title	Credit Hours	Total Credits
1.	Indian Traditional Knowledge	3 (2+1)	**20 (14+6)**
2.	Post-Harvest Management-II	3 (2+1)	
3.	Standards and Certification for Natural Farming	3 (2+1)	
4.	Aqua-based Natural Farming	3 (2+1)	
5.	Marketing of Natural Farming Produce	3 (2+1)	
6.	Agronomic Practices	2 (1+1)	
7.	Intellectual Property Rights	1 (1+0)	
8.	Principles of Agricultural Economics and Farm Management	2 (2+0)	

Semester VII

S. No	Course Title	Credit Hours	Total Credits
1.	Community Mobilization for Natural Farming	2 (1+1)	**21 (13+8)**
2.	Water Management	2 (1+1)	
3.	Research Methodology and Ethics	2 (1+1)	
4.	Weather Forecasting	3 (2+1)	
5.	Basic and Applied Agricultural Statistics	3 (2+1)	
6.	Elective Course-I	3 (2+1)	
7.	Elective Course-II	3 (2+1)	
8.	Elective Course-III	3 (2+1)	

Semester VIII

S. No	Course Title	Credit Hours	Total Credits
1.	For Student opting for 4 Year B.Sc. Ag. (Hons.) Natural Farming Degree Student READY (RAWE/Industrial Attachment/ Experiential Learning/Hands on Training/Project Work)/ Internship	20 credits	**20(0+20)**

Table 2: Semester wise Credit Allocation (NF)

Semester	Total Credits	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Non-Gradial	Online Courses/ MOOC
I	21	10	3[2]		1[3] + 2[4]+1[8]	4	-	2[1]	**10**
II	21	11	3[5]		1[3] + 2[7]	4	10[12]	-	
III	21	15	--	3[6]	1[8]	2	-		
IV	22	14	3[9]	3 [10]	----	2	10[13]	-	
V	20	20	-	-	-	-	-	2[11]	
VI	20	20	-	-	-	-	-	-	
VII	21	12+9*	-	-	-	-	-	-	
VIII	20	-	-	-	-	-	20	-	
Total	**166**	**111**	**9**	**6**	**8**	**12**	**20**	**4**	**10**

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
[2] Farming based Livelihood systems.
[3] NCC/NSS/NSO.
[4] Communication Skills.
[5] Entrepreneurship Development and Business Management.
[6] Environmental Studies and Disaster Management.
[7] Personality Development.
[8] Physical Education, First Aid and Yoga Practices.
[9] Agriculture Marketing and Trade.
[10] Agriculture Informatics.
[11] Study tour (10-14 days).
[12] Only for those opting for an exit with UG-Certificate.
[13] Only for those opting for an exit with UG-Diploma.

Section-Wise Course Breakup

Course Category	Course Title	Credit Hours
Induction cum Foundation course	*Deeksharambh*	2 Weeks (Non gradial)
Common Courses	Farming Based Livelihood Systems	3 (2+1)
	Communication Skill	2 (1+1)
	Entrepreneurship Development and Business Management	3 (2+1)
	Personality Development	2 (1+1)
	Environmental Studies and Disaster Management	3 (2+1)
	Agricultural Marketing and Trade	3 (2+1)
	Agricultural Informatics	3 (2+1)
	NCC/NSS/NSO-I	2 Courses each of 1 (0+1) credits
	Physical Education, First Aid and Yoga Practices	2 credits
	Total Credits	**23**

Course Category	Course Title	Credit Hours
Core courses (Major and Minor)	Indian Heritage of Natural Farming	3 (2+1)
	Principles and Practices of Natural Farming	4 (3+1)
	Bhumi Suposhan (Soil Nutrition)	3 (2+1)
	Cow- Based Natural Farming	3 (1+2)
	Soil Biology in Natural Farming	3 (2+1)
	Integration of Horticulture Crops Under Natural Farming	2 (1+1)
	Insect Ecology, Nematodes and Pest Management	3 (2+1)
	Crop Management in Natural Farming	3 (2+1)
	Production of Bio-Inputs	2 (1+1)
	Farm Power and Machinery	3 (1+2)
	Livestock and Poultry Production	3 (2+1)
	Management of Plant Diseases	2 (1+1)
	Biodiversity Conservation	2 (1+1)
	Elements, Characteristics and Design Of Natural Farming Systems	3 (2+1)
	Improvement Of Traditional and Under-Utilized Crops	3 (2+1)
	Agro-Ecosystem Analysis for Natural Farming	2 (1+1)
	Beneficial Insects	3 (2+1)
	Quantification and Valuation of Ecosystem Services	3 (2+1)
	Post-Harvest Management –I	3 (2+1)
	Bio- Resources and Agricultural Waste Management	3 (2+1)
	Medicinal and Aromatic Plants	2 (1+1)
	Seed Production Technology	3 (2+1)
	Value Chain Management in Natural Farming	2 (1+1)
	Renewable Energy Sources	2 (1+1)
	Natural Farming and Human Health	2 (1+1)
	Fundamentals of Entomology	3 (2+1)
	Indian Traditional Knowledge	3 (2+1)
	Post-Harvest Management-II	3 (2+1)
	Standards and Certification for Natural Farming	3 (2+1)
	Aqua-Based Natural Farming	3 (2+1)
	Marketing of Natural Farming Produce	3 (2+1)
	Agronomic Practices	2 (1+1)
	Intellectual Property Rights	1 (1+0)
	Principles of Agricultural Economics and Farm Management	2 (2+0)
	Community Mobilization for Natural Farming	2 (1+1)
	Water Management	2 (1+1)
	Research Methodology and Ethics	2 (1+1)
	Weather Forecasting	3 (2+1)
	Basic and Applied Agricultural Statistics	3 (2+1)
	Total Credits	**102 (63+39)**
Elective courses	9 Credits will be taken from list of choice based course list or department wise courses to be decided by host institution	9
	Total Credits	**9**
Skill Enhancement Courses	Skill Enhancement Course I	2 (0+2)
	Skill Enhancement Course II	2 (0+2)
	Skill Enhancement Course III	2 (0+2)
	Skill Enhancement Course IV	2 (0+2)
	Skill Enhancement Course V	2 (0+2)
	Skill Enhancement Course VI	2 (0+2)
	Total Credits	**12 (0+12)**
Student READY		20
	Total Credits	**20**

SUMMARY OF CREDIT DISTRIBUTIONS

Type of course(s)		Credit hours
Core courses	:	111
Skill Enhancement courses	:	12
Multidisciplinary/ Common courses	:	23
Student READY/Internship	:	20
*Online courses (non-gradial)	:	10
Grand Total	:	**166+10***

The credits of *Deeksharambh* (0+2) and Study tour (0+2) being non-gradial have not been included in the total 166 credit hours.

Detailed Syllabi

Semester I

Deeksharambh(Induction cum Foundation Course) 2 (0+2) (Non-Gradial)

The details of activities will be decided by the host universities. The structure should include, but not restricted to:

(i) Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University.

(ii) Interaction with alumni, business leaders, scientists and prospective employers

(iii) Group activities to identify the strength and weakness of students (with expert advice for their improvement), streaming of the students as per their aptitude for research entrepreneurship or others through psychometric test as well as to create a platform for students to learn from each other's life experiences

(iv) To identify the students having difficulty in mathematics and enrolling them for 1 non-gradial remedial course on mathematics of one credit

(v) Activities to enhance cultural integration of students from different backgrounds.

(vi) Classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, Knowing and Being etc.) and communication skills.

Indian Heritage of Natural Farming 3 (2+1)

Objectives

1. To impart knowledge on the heritage of natural farming in ancient India and various techniques of *Vedic Krishi*.
2. To develop skills on *Vedic Krishi* practices for practicing natural farming.

Theory

The heritage of natural farming, Pioneers and scholars of natural farming and their contribution to the heritage of natural farming, Ancient methods of livestock management, health, nutrition, soil fertility and plant protection, Description on ancient methods of rainfall prediction, Importance of seed and their collection, storage, removal of weed seeds and seed uniformity, Discussions on important rare documents like *Krishi-Parashar*, *Sitadhyaksha* chapter in *Kautilya Arthashastra* (Acharya Kautilya-321 BC), *Kashyapiya Krishi Sukti* (by sage Kashyap-c.800 CE), *Vrikshayurveda* (by Vaidya

Surapala), *Upavanavinod* (Nalini, 2011), *Vishwavallabha* (by Chakrapani Mishra-1577 CE), *Brihat Samhita* (by Varahamihi- 600 AD), *Lokopakara* (1000-year-old manuscript), *Nuskha Dar Fanni-Falahat*-The Art of Agriculture(by Prince Dara Shikoh-1650 CE), *Krishi Gita-Agricultural Versus* (15th century by Vidwan C Govinda Warriar), etc. Measurement of wealth on natural resources, '*Gau-dhan*' (Cows), *'Ashwa-dhan*' (Horses), '*Gaj-dhan*' (Elephants) etc. as all different forms of wealth.

'*Vidya-dhan*'. The most important wealth *'dhanya*' or rice/crops, Mode of the transactions in the society through '*dhanya*'. Broad tradition of 'natural farming', propounded by advocates such as Dr Y.L Nene, (Asian Agri History Foundation), Narayana Reddy (Karnataka), Shripad Dabholkar (Maharashtra), G Nammalvar (Tamil Nadu), Partap C Aggarwal (Madhya Pradesh) and Bhaskar Hiroji Save (Gujarat). Rich heritage of plant protection in natural farming, Identification of disorders; Surapala's Vrikshayurveda describes various plant diseases based on Tridosha (Vata, Pitta, Kapha) Siddhanta of Ayurveda along with symptoms and remedial measures. Plant protection practices, Kunapajala, Herbal Kunapajala and other indigenous liquid concoctions.

Practical

Visit of natural farms to understand the concept, components and management practices. Identification of plant and animal-based products used in Vrikshayurveda for plant nutrition and crop protection. Preparation of Vrikshayurveda based on-farm inputs for nutrient, pest and disease management. Documentation of vrikshayuveda technology knowledge- base for resource conservation, soil health and plant protection.

Suggested Readings

1. Akbar R. 2000. Nuskha Dar Fanni-Falahat (The Art of Agriculture) by Prince Dara Shikoh (1650 CE): AAHF Classic Bulletin 3. Asian Agri- History Foundation, Secunderabad, AP, India. 88pp.
2. Ayachit SM. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri- History Foundation **4**:205.
3. Beniwal, SPS and Pandey ST. 2022. Soil nourishment and conservation according to soil agriculture heritage of India, Bhumi Suposhan Commemorative Publication 43-56p
4. Beniwal, SPS, Nene yL, and Pandey ST. 2020. Relevance of *Vrikshayurveda* and Traditional Knowledge for Eco-friendly Sustainable Agriculture to Meet SDGs in India. *Asian Agri-History* **1**:3-22.
5. Bhat, M and Ramakrishna. 1992. Varahmihira's Brihat Samhita. Motilal Banarasidas, Delhi India 561pp.
6. Das, P, Das, SK, Arya, HPS, Reddy, Subba G, Mishra, A and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
7. Gupta, PK and Gupta, AK ed. 2019. Smriti Jaagran Ke Harkaare, Jeevika Livelihoods Support organization, Jabalpur, MP, India.
8. Kumar, B. Mohan 2008. Krishi Gita (Agricultural Verses) by Vidwan C Govinda Warriar (Ed.): AAHF Classic Bulletin 7. Asian Agri-History Foundation, Secunderabad, AP, India. 134pp.

9. Nalini, S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Secunderabad, AP, India. 94pp.
10. Nalini, S. 1999. *Krishi-Parashara (Agriculture by Parashara) by Parashara*, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
11. Nalini, S. 2004. Vishva Vallabha (Dear to the World: The Science of Plant Life) by Chakrapani Mishra (1577 CE): AAHF Classic Bulletin 5. Asian Agri-History Foundation, Secunderabad, AP, India. 134pp.
12. Nalini, S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Secunderabad, AP, India. 64pp.
13. Nene YL. 2006. Kunapajala – A Liquid Organic Manure of Antiquity; Asian Agri History **4**: 315-21.
14. Nene YL. 2012 A. Potential of some methods described in Vrikshayurveda in crop yield increase and disease management. *Asian Agri-History* **1**: 45- 54p.
15. Nene YL. 2012 B. Crop Disease Management Practices in Ancient, Medieval, and Pre- modern India. *Asian Agri-History* **3**: 185-201p.
16. Saxena, RC, Choudhary SL and Nene yL. 2009. A Textbook on Ancient History of Indian Agriculture. AAHF Text Book. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP, and Rajasthan Chapter of Asian Agri-History Foundation, Udaipur, India. 139pp.
17. Sreenivasa, AV. 2004 a. Herbal kunapa. Asian Agri-History **8**:315–17.
18. Sreenivasa, AV. 2004 b. Manujala: A liquid manure. Asian Agri-History **8**: 319–21.
19. Sreenivasa, AV. 2005. INDSAFARI – An organic pesticide for tea. Asian Agri-History **9**:317–19.
20. Watt G. 1889. A dictionary of the economic products of India, *Central Secretariat Library*. https://indianculture.gov.in/rarebooks/dictionary- economic-Products-India- vol-iv

Principles and Practices of Natural Farming **4 (3+1)**

Objectives

1. To make the students aware about the agro-ecology, concept and principles.
3. To impart knowledge on various principles and practices in natural farming.
4. To impart knowledge about different methods of natural farming.

Theory

Natural farming: Concept and importance. Modern agriculture and need for new strategies, origin of concept of natural farming, Agroecology: Concept and Principles, history of development in agro-ecology, Natural farming: principles, philosophy and components, Merits and demerits of natural farming, Principles of Fukuoka and other methods of natural farming, Practices of Natural Farming - case studies, Types of natural farming systems (Community based natural farming, Palekar's Natural Farming, Bio-dynamic, homa farming, natu- eco farming, rishi Krishi, panchagavvya Krishi, yogic farming etc., Scope of natural farming in modern time, Laws of nature, Indian philosophy /Bhartiya Chintan of Pancha Mahabhoot and their role in human life and

development, Important management practices for crops, fruits, vegetables and animals in natural farming, comparison of conventional, organic and natural farming production systems, Scientific aspects of ecological and natural farming for supporting food, nutritional and livelihood security - food sovereignty, livelihood of farmers and rural communities, biodiversity and conservation of biodiversity, Sustainable soil health and clean water, Ecological pest protection, Climate resilient food production, Indigenous farming systems prevalent in India and other countries. Government schemes supporting natural farming (PKVy, BPKP, National Mission on Natural Farming), Start-Ups in chemical free agriculture, Digital India.

Practical

Identification of indigenous crops and practices, Study of different farming systems and their characterization, Students' visit to natural farms to study the various components and practices of natural farming, Development of natural farm inventarity, Analysis of ancient Indian and modern natural farming, Bio- dynamics, homa farming, natu-eco farming, rishi Krishi, panchagavvya Krishi, Yogic farming and practical field application of these practices, Design of natural farm based on locally available resources, Preparation of on- farm inputs for nutrients, pest and disease management. Documentation of indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management, Development of documentary on management of natural farm.

Suggested Readings

1. Behera, UK. 2013. A Text Book of Farming Systems. Agrotech Publishing House, Udaipur, Rajasthan
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, Subba G., Mishra, A. and others- Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi
3. Ecological Farming, 2015. The seven principles of a food system that has people at its heart, Greenpeace.
4. Fukuoka M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
5. Hill S.B. and ott P. (eds.). 1982. Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
6. Kamlagat Prakritkriti by Acharya Devvrat, pp 1-166.
7. Khurana, A. and Kumar, V. 2020. State of organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
8. Malhotra R. and Babaji SD. 2020. Sanskrit Non Translatables- The importance of Sanskritizing English. Amaryllis, New Delhi, India.
9. Nicole Faires. 2016. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides)
10. Prathapan Paramu. 2021. Natural Farming Techniques: Farming without tilling
11. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, ottho Heldringstraat.

12. Sharma, S. K., Choudhary, R., Ravishankar, N., Jat, G., Sharma, R. K., Yadav, S. K. and Jain, R. K. 2022. Natural Farming: Concept, Importance, Scope and Status. Technical Bulleting, Directorate of Research, Maharana Pratap University of Agriculture and Technology, Udaipur. Pp 1-16.
13. Shripad A. Dabholkar and Prayog Pariwar. 2021. Plenty For All: Natural Farming A To Z Prayog Pariwar Methodology.

Bhumi Suposhan (Soil Nutrition) 3 (2+1)

Objectives

1. To impart knowledge on various properties of soils, soil evaluation procedures, factors of soil fertility and management of biological processes through natural farming practices
2. To develop skills among students on soil management practices under natural farming

Theory

Soil as a natural medium for plant growth, Status of soil degradation; Weathering of rocks and minerals, Soil genesis and classification; Concept of essential, beneficial, functional and trace elements in soils; Role of essential nutrients in plants, their deficiency and toxicity symptoms and diagnosis, Nutrient movement in soils and mechanisms of nutrients uptake by plants, Cycling of nutrients in soils (C, N, P, S, secondary and micronutrients), Importance of physical, chemical, and biological properties of soil, Factors affecting soil fertility, Methods of soil fertility evaluation: physical, chemical and biological, origin, formation, extent of distribution and characteristics of acid soils, acid sulphate soils, alkali soils, saline soils and their management, Formation of soil organic matter and its management in agroecosystem, carbon sequestration, soil carbon and nitrogen management indices, Soil quality and health, soil quality indicators, characteristics of a healthy soil, Principles of supporting healthy rhizosphere interactions for improved soil fertility, Best management practices (BMPs) for promoting soil health and monitoring of soil-health: minimum tillage, mulching, organic residue incorporation, cover crops, green manuring, crop rotation, conducive environment for beneficial microbes, mixed cropping, intercropping, composts, FYM, biochar, bio- culture formulations, Sing Khad, (Horn manure), *Kunapajal*, Samadhi Khada, biogas manures (liquid and solid), etc., Principles and methods of production of various organic manures, Sources of contamination in soil and reclamation by bioremediation processes (Phytoremediation, phytoextraction, phytostabilization and microbial bioremediation), Ancient classification of soil based on soil fertility, irrigation, physical characteristics, and crop suitability; Ancient practices for soil enrichment under natural farming, Traditional festivals of the region with respect to soil health, Schemes promoting soil health in India.

Practical

Soil sampling methods, processing, and storage, Determination of soil texture (feel method, hydrometer method and international pipette method), Determination of soil bulk density, particle density, porosity, and water holding capacity, Determination of soil pH and EC, Determination of soil organic carbon, Determination of available nitrogen, Determination of available phosphorus, Determination of available potassium, Determination of available secondary plant nutrients (Ca, Mg, S,), Determination of available micronutrients (Zn, Fe, Cu, Mn, B, Mo), Plant sample digestion procedure, Analysis of important nutrient elements in plant, Studies on important ITKs for selection of crop-soil combination, Quantification of carbon-neutral farming practices.

Suggested Readings

1. Akshay Krishi Parivar.2022. Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP ublication No.11. Pp.212.
2. Biswas, T.D. and Mukherjee S.K. (1987) Text Book of Soil Science. Tata McGraw- Hill Publishing Company, New Delhi. ISBN 13, 0074516795, 9780074516799. Pp. 314.
3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (2000) Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India. Pp.363.
4. Das, D.K. (2015) Introductory Soil Science. 4th edn, Kalyani Publishers, ISBN-13.978-9327257540
5. Das, P., Das, Reddy, G.S., Das S.K., Rani G., Mishra A., Gupta H.P., Verma L.R., Ray D.P., Singh R.P., Kavia Z.D., and Arya H.P.S. (2004) Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
6. Gaur, A.C. (1999). Microbial Technology for Composting Residues by Improved Methods. ICAR, New Delhi. Pp. 78.
7. Havlin, J.L., Tisdale S.L., Nelson W.L. and Beaton J.D. (2016) Soil Fertility and Fertilizers. 8th edn, Pearson Education India. ISBN 978-9332570344.
8. Indian Society of Soil Science (2012) Fundamental of Soil Science, published by Indian Society of Soil Science (ISSS). 2nd edn, ISBN 13 8190379747.
9. Rattan, R.K., Katyal J.C., Dwivedi B.S., Sarkar A.K., Bhattacharyya T., Tarafdar J.C. and Kukal S.S. (2015) Soil Science: An Introduction. Indian Society of Soil Science, New Delhi. ISBN 13, 978-8190379779
10. Weil, RR and Brady NC. (2021) The Nature and Properties of Soil. 15th edn, ISBN 978-9356062719.
11. Yawalkar, K.S., Agarwal J.P. and Bokde S. (2012) Manures and Fertilizers. Agri- Horticultural Publishing House. Pp. 288.

Farming based Livelihood Systems 3 (2+1)

Objective

To disseminate the knowledge and skill how farming systems can be a source of livelihood

Theory

Concept of farming system and integrated farming system- Definition, goal and advantages, Classification of farming systems, Components of farming systems- Crops and cropping systems, Livestock and poultry, Fishery and Secondary enterprises, Integration of components in farming system, Factors affecting integration of components in IFS, Selection of crops and cropping systems for various enterprises, Feasibility of different cropping systems for different agro- climatic zones, Horticultural crops and cropping systems feasible for different farming systems, Livestock and poultry as a component of integrated farming systems, Study of different livestock components

feasible for IFS (Dairy, Piggery, goatry, poultry, duckry etc.), Aqua culture as a component of IFS, Duck/Poultry cum Fish, Dairy cum fish, Piggery cum fish etc. Problems, profitability and prospects, Sericulture as a component of IFS: Scope and potentiality of sericulture for small and marginal farmers of states, some suitable module of IFS for different agro-ecological situations, Commercial livestock production- problems and prospects, Design for livestock shed and their maintenance, Importance of feed processing unit for livestock production, Silage and hay production, Marketing, Concept of sustainable farming system and their indicators.

Practical

Study of IFS models for different agroclimatic zones, Preparation of IFS model in groups, Recycling of organic waste in IFS, Study of production and profitability of IFS, Market survey for IFS products, Preparation of organic manures in IFS, Study of crops and cropping systems for diversification in IFS, Visit to farmer's field for feasibility study for scientific intervention in IFS, Study of Integrated Organic Farming Systems.

Suggested Readings

1. Indian Institute of Farming Systems Research, Modipuram.
2. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced income and employment, Indian Council of Agricultural Research, New Delhi.
3. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
4. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-
5. Walia, S S and U S Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.
6. Neuliep James W, 2003, Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.
9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

Skill Enhancement Course

Objective

- To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list of issues related environment.
- Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rainwater harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management. Disaster management. Introduction and classification of disaster, rehabilitation, and management after disaster; role of NSS volunteers in disaster management.
- Entrepreneurship development. Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.
- Formulation of production-oriented project. Planning, implementation, management, and impact assessment of project. Documentation and data reporting. Collection and analysis of data, documentation, and dissemination of project reports

Skill Enhancement Courses 4 (0+4)

Two Courses each of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

National Cadet Corps (NCC-I) **1(0+1)**

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

Or

National Service Scheme (NSS-I) **1 (0+1)**

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Semester I: Introduction and Basic Components of NSS

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Physical Education, First Aid, Yoga Practices and Meditation 1(0+1)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory &Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra

- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester II

Cow Based Natural Farming 3 (1+2)

Objectives

1. To acquaint the students about practicing natural farming involving cow and its relationship with farming activities
2. To impart skill on farming practices and technologies in cow based natural farming

Theory

Sociology of natural farming, Indian Livestock scenario, Indigenous breeds of cattle, Differentiating features of indigenous, crossbred and exotic cattle, Traditional livestock farming practices, Draft animal power in natural farming, Feeding cattle at various phases, Forage production, Hay making, Preventive health care practices, Bio efficacy of cow urine on crop production, Effect of different natural inputs on yield, quality and soil properties, Effects of cow urine and its major constituents on pasture properties, Cow based rearing systems: land, feed and water requirement of traditional farming method, Advantages of cow based natural farming methods, Economics of cultivation and comparison with currently adopted practices, Role of cow based farming system in utilising the available cattle (*Desi* cow) as valuable resource, Cost of cultivation under cow based natural farming, Composition and constituents of desi cow milk vs cross breeds; role of tryptophan precursor of serotonin in relaxing human mind and better sleep, role of A2 Milk in controlling blood sugar level. Sustainable agriculture and fodder business, Natural farming business and entrepreneurship development, Supply chain management, Application of bio gas in agriculture, Traditional therapies for various ailments, ITKs in cow based natural farming.

Practical

Identification and characteristics of various cattle breeds, fodder varieties and feed ingredients; Visit to dairy farm to study the various components and their utilization, Visit to *gau-shala*, Visit to an institute involved in cow based natural farming, Design and development of cow based natural

farm, Identification of herbal plants used for livestock treatment, Ethno veterinary medicines,; Feed and fodder conservation practices-Silage and Hay making, Concentrate making techniques including ration balancing for cow based farms, Calf management under natural Farm, Value addition of milk from dairy, Grassland management, Value addition of by-products from cow based natural farm, Bio- inputs preparation for natural farms, Traditional practices followed in cow-based natural farms, Record keeping and economics of cow based natural farming, Preparation of inputs for cow based natural farming, Demonstration of renewable energy sources in cow based natural farms.

Suggested Readings

1. Gaur, AC, Handbook of organic Farming and Biofertilizers.
2. Dahama, AK organic Farming for sustainable agriculture. Agrobios (India), Jodhpur.
3. Banerjee, GC. 1989. Text Book of Animal Husbandry. oxford and IBH.
4. Chander, M, and Subrahmanyeswari, B. 2017. organic Livestock Farming. Indian Council of Agricultural Research.
5. Das, P, Das, SK, Arya, HPS, Reddy, G, Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi
6. ICAR. 2022. Handbook of Animal Husbandry. ICAR Publication.
7. Nivsarkar, A. E., Vij, P. K. and Tantia, M. S. 2000. Animal Genetic Resources of Indian Cattle and Buffalo, by ICAR- KAB, New Delhi- 110012, pp 382.
8. Sastry, N.S.R., and Thomas, C.K. 2019. Livestock Production Management. Kalyani Publishers, New Delhi.
9. Sastry, NSR and Thomas, C.K. 1991. Dairy Bovine Production. Kalyani Publishers.
10. Taparia, A.L.2007.A Historical overview of Animal Husbandry in Ancient and Medieval India. In. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp.151-156.
11. Thomas, C.K. and Sastry, NSR. 2013. Livestock Production Management. Kalyani Publishers.

Soil Biology in Natural Farming 3 (2+1)

Objectives

1. To impart knowledge on various aspects of soil biology, biological interactions and their roles in management of soil quality and productivity.
2. To develop skills among students on isolation, purification, identification and use of soil beneficial microbes and fauna in natural farming system

Theory

Soil as a habitat for life, concept of soil biome and its components, Soil organic matter: Definition and its characterization, Biochemical processes of formation of soil organic matter, SOM as carbon source for soil biota, Decomposition processes, reaction order and its dynamics, Soil biodiversity

and its methods of evaluation, Soil microbiota: its distribution and abundance, metabolism and physiology, classification of soil microorganisms and their importance in soil processes, Soil fauna (microfauna, mesofauna, macrofauna and megafauna): distribution, abundance, diversity and interactions; Factors affecting soil biodiversity, Significance of biota in soil development, Soil biological interactions: Functions and processes, Above- ground and below-ground biotic linkages, Rhizosphere, spermosphere, phyllosphere and their use in crop growth and development, Habitat adaptive fitness benefits to host crops in terms of tolerance to abiotic and biotic stresses, Biological nitrogen fixation: Symbiotic (*Rhizobium*-legume, Actinorhizal, *Azolla-Anabaena*), Associative (*Azotobacter*, *Azospirillum*, *Gluconacetobacter*, etc.), Free-living (BGA, *Klebsiella,* etc.), Microbiological methods of composting: various composting techniques, biofortification of various organic manures, *In- situ* decomposition techniques of crop residues using decomposers, Mechanisms of Biological Nitrogen Fixers (BNF), factor affecting BNF, Microbial mediated nutrient availability and exchange in soil, Nutrient mobilization, Arbuscular mycorrhizal symbiosis: its types, biochemical basis of interactions and benefits to host crops, Soil enzymes -characterization and mode of action, Agricultural management impacts on soil enzyme activities, Soil health, soil sickness, soil resistance concept, indicators and evaluation criteria, ITKs on soil health management through enriching soil microbiome.

Practical

Hands on microscopy and examination of microbes, Microbiological media and methods of sterilization, Isolation and purification of microbial cultures, Enumeration of microbial population in soil- bacteria, fungi, actinomycetes, Isolation of *Azospirillum*, *Azotobacter*, BGA, *Rhizobium,* Determination of microbial biomass C and N, Assay for soil enzyme activities, Assay for carbon substrate utilization, Determination of earthworm population and biomass, Estimation of soil carbon active pool (Co_2 evolution, SMBC), Estimation of different carbon fractions of soil, Estimation of soil carbon stock.

Suggested Readings

1. Bloem J., Hopkins D.W. and Benedetti A. 2006. Microbiological Methods for Assessing Soil Quality. CABI Publishing. Wallingford.
2. Chhonkar, P. K., Bhadraray S., Patra A. K. and Purkayastha T. 2007. Experiments in Soil Biology and Biochemistry. Westville Publishing House, New Delhi. Pp. 169.
3. Elasas, J.D.V, Jansson J.K. and Trevors. 2006. Modern Soil Microbiology. 2nd edn. CRC Press. Boca Raton.
4. Indian Society of Soil Science. 2015. Introduction to Soil Science. ISSS, New Delhi.
5. Kannaiyan, S, Kumar K and Govindarajan, K. 2004. Biofertilizers Technology. Scientific Publ.
6. Lal, R and Shukla, MK. 2004. Principles of Soil Physics. Marcel Dekker.
7. Mengel, K and Kirkby, EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland. Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
8. Paul, E.A. 2007. Soil Microbiology, Ecology and Biochemistry, Third Edition. Academic Press, Amsterdam. Pp.514.

9. Richard Bardgett.2005. The Biology of Soil. A Community and Ecosystem Approach. oxford University Press. Pp.231.

10. Subba Rao, N. S. 2009. Soil Microorganisms (4th edn of Soil Microorganisms and Plant Growth), oxford and IBH Publishing Co. Pvt. Ltd. pp. 387.

Integration of Horticultural Crops under Natural Farming 2 (1+1)

Objectives

1. To acquaint the students with package and practices for horticultural crops under natural farming.
2. To impart the practical training on horticultural crop production.

Theory

Importance and scope of horticulture crops in natural farming, Soil management in relation to nutrient and water uptake and their effect on soil environment, Intercrops- types and its role in nutrient management, Biological efficiency of cropping systems in horticulture, Planting of fruit plants in combination with annual crops – principles and strategies, Types of planting system for fruit plants in natural farming, Competitive and complimentary effect of root and shoot systems, Type of mulches - sod mulch and organic mulches for soil moisture and nutrients management, Irrigation – defined systems of irrigation for natural farming in fruit crops, Soil microbes and their role for sustainable horticultural crop production system, Canopy management, Training and pruning, Methods of training and training of important fruit trees, High density planting (HDP) and meadow orchards and their management, Rejuvenation of old orchards - top working and frame working, Integrated pest and disease management (IPDM), Integrated nutrient management (INM), Crop regulation in relation in fruit crops, Management of resources constraints in existing systems, Climate aberrations and mitigation measures of horticultural crops, Management of fruit plants of important tropical, sub-tropical and temperate fruit crops under natural farming, Mulching of fruit crops and Whapasa management, ITK for management of fruit plants under natural farming system.

Practical

Selection of site for farm system design for establishment of natural farming of horticulture crops, different planting systems and its layout – Triangular system, contour lines, double row system, rectangular and square, Preparation of pit and procedures for filling, Soil depth and slope for fruit tree plantation, Irrigation methods and application of water to fruit crops, Growing of intercrops ginger, turmeric, colocasia, cowpea, cabbage and green manuring, Filler crops – definition and their use in young orchard, Training and pruning methods of important tropical, sub-tropical and temperate fruit crops, Weed management in orchards, Use of plant-based products and microbes for plant protection of tropical, sub- tropical and temperate fruit crops, Mulching of fruit crops and Whapasa management

Suggested Readings

1. Agriculture. ICAR. Document 2, Supplement 1. 84-100 pp.

2. Agriculture. ICAR. Document 2, Supplement 2. 111-136 pp.

3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous

Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Horticultural Crops / Pest and Disease Management / Soil and Water conservation/ Soil fertility Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR New Delhi.
5. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in
6. Horticultural Crops. 2004. Inventory of Indigenous Technical Knowledge in
7. K. K. Sharma and N.P. Singh. 2021. Soil and orchard Management. Daya Publishing House.

Insect Ecology, Nematodes and Pest Management 3 (2+1)

Objectives

1. To teach students the insect ecology and effect of biotic and abiotic factors on pests
2. To impart practical knowledge on various plant protection options under natural farming
3. To impart knowledge on plant parasitic nematodes and management options under natural farming

Theory

Insect Ecology - Introduction, environment and its components, Effect of abiotic factors – temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents, Effect of biotic factors – food competition, natural and environmental resistance, Categories of pests, Storage pests. Solutions for insect-pest control in natural farming: surveillance, perimeter weeding, conventional land preparation, host plant resistance, interaction of plant resistance traits and biocontrol agents, crop rotation and planting practices (date of sowing), intercropping/ mixed cropping, trap crops, border crops, sanitation, conserving natural enemies via habitat enrichment, Physical control strategies to reduce pest incidence, Mechanical control, Behavioral control (repellents and anti-feed ants plants, Biological control (Importation, Conservation, Augmentation; Parasitoids predators and Pathogens), Factors affecting success of biological control: Narrow host range/ Climatic adaptability/ Synchrony with host life cycle / High reproductive potential / Efficient search ability/ Short handling time / Survival at low host density, Botanicals (Plant extracts), Plant bioformulations: agniaster, brahmaster, neemaster, dasparni ark etc. Management of stored grain pests by non-chemical methods.

History and economic importance of nematodes: General characters of plant parasitic nematodes, their morphology, symptomatology and control of important plant parasitic nematodes of field and fruits by non-chemical methods, Use of various plant bioformulations like agniaster, brahmaster, neemaster, dasparni ark *etc*. for nematodes and pest management.

Practical

Sampling techniques for estimation of insect-pests and nematodes populations, Collection of insect-pests, nematodes, natural enemies and their identification, Diversity of insect- pests, nematodes, Calculation of diversity indices, Preparation of different bioformulations and their application methods.

Suggested Readings

1. DeBach, P. (1973). Biological control of Insect Pests and Weeds. Chapman and Hall, New York. 844p.
2. Dhaliwal. G.S., Ram Singh and Vikas Jindal. 2013. A Textbook of Integrated Pest Management. Kalyani Publishers, Ludhiana, pp. 617.
3. Panwar, V.P.S. 2014. Agricultural Insect Pests of Crops and Their Control. Kalyani, Publishers, New Delhi.
4. Pest and Disease Management. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publication: ICAR New Delhi.
5. Southwood, T.R.E. and Henderson, P.A. (2000) Ecological Methods. Third Edition, Blackwell Science, USA, 575p.
6. Walia, R.K. and Bajaj, H.K. 2014. Textbook of Introductory Plant Nematology (2nd edn), Kalyani Publishers, New Delhi.

Entrepreneurship Development and Business Management: 3 (2+1)

Objectives

1. To provide student an insight into the concept and scope of entrepreneurship.

2. To expose the student to various aspects of establishment and management of a small business unit.

3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

- Charantimath P.M., 2009., Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
- Desai,Vasant. Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
- Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
- Grover Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
- Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
- Mehra P. 2016, Business Communication for Managers. Pearson India, New Delhi.
- Pandey M. and Tewari D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
- Singhal R.K. 2013. Entrepreneurship Development and Management, Katson Books.
- Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B., 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R., 2009, Social and Personality Development (6th edn). Belmont, CA: Wadswor.

Skill Enhancement Courses 4 (0+4)

Two Courses each of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

National Cadet Corps (NCC-II) 1 (0+1)

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

Or

National Service Scheme (NSS-II) 1(0+1)

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load.

The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Semester III

Crop Management in Natural Farming 3 (2+1)

Objectives

1. To acquaint students with the concepts of selection of crops and their cultivation practices under specific agroecological zones following natural farming principles
2. To train the students about package of practices of different crops under natural farming

Theory

Selection of crop and variety – Criteria for selection of crops in natural farming, Traditional and indigenous variety - Advantages and disadvantages - Classification of crops - factors affecting selection of crops and variety, Importance of pulses of legumes in natural farming, Weather management- Concept of weather and climate, Factors affecting crop production: climatic factors, edaphic, biotic, physiographic etc., micro-climate management techniques, Windbreaks and shelter belts, Management of weather in natural farms, Seed, sowing and Irrigation– Importance and concept of seed selection, seed treatment, Seed rate- Factors affecting seed rate and seed germination, sowing- time, method and depth, indigenous methods and animal drawn techniques, time and method of irrigation, management of irrigation, ITKs in seed, sowing and water management, Crop

Geometry: Definition of crop geometry and crop density, types of crop geometry, importance of crop geometry, thinning, gap filling, optimum plant population, factor affecting plant population, relation of crop geometry and growth, relation of crop geometry and yield, Weed management: Classification of weeds and their importance, methods of weed management, practices of weed management in natural farming, Nutrient management: Sources of nutrient application and their management in natural farming and modern agriculture, maintenance of soil health and plant health, under natural farming, Package of practices of crops under natural farming.

Practical

Selection of crops for natural farming according to agro-ecological zones, Know how on agro-met observatory and data interpretations, Calculation of seed rate for sowing, Plant geometry and population calculation, Traditional seed treatment methods, Preparation of traditional nutrient supply concoctions and their uses, Traditional knowledge techniques in crop management and on-farm waste management, Study of methods of crop residue management, Study of important methods of plant protection, Irrigation efficiency, Preparation of crop calendar for different sowing seasons under various micro-climates.

Preparation of contingency crop plan for natural farming, yield estimation in naturally grown crops, Field visit to natural farm, Documentation of sustainable natural farming practices.

Suggested Readings

1. 100 Herbs for making JADAM Natural Pesticide: The way to Ultra-Low- Cost agriculture (JADAM organic Farming) by Geol yu, youngsang Cho, et al. (2016).
2. Agronomy Principles and Practices. 2017 by E. Somasundaram and M. Mohamed Amanullah, New India Publishing Agency, New Delhi.
3. Crops and Cropping Systems. 2004. *In*: Inventory of Indigenous Technical Knowledge in Agriculture Document 2 (Supplement 1) pp 9-26. Publ: ICAR, New Delhi.
4. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
5. Fundamentals of Agronomy, Gopal Chandra De, 2017, oxford and IBH publication.
6. Natural, Organic, Biological, Ecological and Biodyanamic Farming by V. N. Tivari (2010).
7. Principles of Agronomy, S.R. Reddy, 2020, Kalyani Publications. New Delhi.
8. Principles of Agronomy, T. Yellamanda Reddy and G. H. Shankara Reddy, 2016, Kalyani Publications, New Delhi.
9. Scientific Pulse Production, 2003, by P.S. Rathore and S.K. Sharma, Yash Publishing House, Bikaner, pp. 1-269.
10. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016).
11. Vrikshayurvedic Farming: The Traditional Indian Agriculture by C and Mujh R Nandha Kumar Swaminathan (2017)

Production of Bio-inputs 2 (1+1)

Objective

1. To impart knowledge on types of bio-inputs, their functions, compositions, application doses and impacts on soil processes
2. To develop skills among students in mass production of various bioinputs, their application methods and quality control

Theory

Definition and types of bioinputs, Importance of bioinputs, Mechanism of action of bioinputs, Quality standards of bioinputs, Methods of production and application doses of bioinputs, Factors affecting the product quality, Green manures, *Achhadana*, Cow-based bioproducts (*Beejamrutha, Jeevamrutha, GhanJeevamrutha* and other inputs (*agniaster, brahmaster, neemaster, sonthaster, Khatti lassi, dasparni ark, Kanupajala and saptdhanyaankur*) for pest, disease and nutrient management, compositions/ingredients of various bioinputs and their relative merits, Effects of bioinputs on soil biological components, their activities, soil enzymes and overall soil fertility, Impact of bioinputs on plant physiological activities and physiological stress indicators, Influence of bioinputs on plant-microbe and plant- faunal interactions, Initiatives taken by government(central/state), NGOs and other organizations in India for promotion of bioinputs under natural farming perspectives, Economic considerations, viability, marketing and export potential of different bioinputs, Quality aspects, grading, packaging, handling, and establishment of internal control system for bioinputs, Project formulation on bioinputs in natural farming.

Practical

Definition and types of bioinputs, compositional analysis (nutritional and microbiological), Assay on mode of action of bioinputs, Preparation of animal manure-based bioinputs and their uses, Preparation of *Beejamrutha, Jeevamrutha, Ghana Jeevamrutha*, soil microbes based improved bioinputs, mass production and its uses; Preparation of *Bramhaster* and their uses, Preparation of *Agniaster*, *Neemaster* and *Dashparni ark*, their mass production and uses, Preparation of plant-extract based bioinputs, Ginger-Garlic- Chilli extract and their use, Preparation of fermented butter milk and their uses, Preparation of herbal *kunapajala* and Neem -based concoctions and their specific uses, Study of physical, chemical and biological characteristics of important bioinputs, Determination of plant physiological stresses upon application of bioinputs.

Suggested Readings

1. Agri-History Report No. 1. Asian Agri-History Foundation. pp. 36.
2. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Gaur, A.C. 1999. Microbial Technology for Composting of Agricultural Residues by Improved Methods. Indian Council of Agricultural Research, New Delhi, Pp.78.
5. Nene YL. 2003. Crop Disease Management Practices in Ancient, Medieval, and Pre- modern India. Asian Agri-History. Vol. 7(3):185-201.
6. Nene YL. 2007.Plant Pathology in India Prior to Twentieth Century. *In.* Nene yL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
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11. Sharma, Arun. Biofertilizers. Agrotech Publishing Academy, Udaipur
12. Sreenivasa, Ayangarya Valmiki. 2006. organic Tea – A Vrikshayurveda Experience.

Farm Power and Machinery 3 (1+2)

Objectives

1. To enable the students to understand the basic of farm power and machinery use in natural farming
2. To gain the knowledge and skills necessary to effectively and efficiently manage farm machinery, optimize power utilization, and improve overall farm productivity.

Theory

Mechanization in agriculture: its potential and prospects, Sources of farm power, Draught animal power and its relevance to Indian Agriculture, Familiarization with different engine systems, Familiarization with different systems of I.C. engines, working principles of I C engines, Components of IC engine, Use of bio- diesel/bio-ethanol as alternative fuel for engines, Familiarization with tractor, Introduction to primary and secondary tillage equipment, Energy efficient improved tools and equipment's in natural farming: Introduction to rotavator, planter, vegetable transplanter, bed former, disk harrow, mulch laying equipment, Ergonomically improved hand tools for intercultural operations: wheel hoe, long handle hoe, garden tools, labour saving/drudgery reducing tools, Plant protection equipment: knapsack sprayer, power sprayer, threshing and shelling machinery, Animal drawn farm equipment/tools: Animal drawn bund former, Seed drill, Planters, cultivator, ITK in farm machinery, ITKs on farm tools.

Practical

Study of different engine systems, Study of the different components of IC engines, Familiarization with tractor, Familiarization with tools and equipment for input production in field,

Familiarization with tractor drawn primary and secondary tillage implements, Familiarization with animal drawn primary and secondary tillage implements, Familiarization with tractor drawn seed-cum- fertilizer drills their seed metering mechanism and calibration, Familiarization with animal drawn seed-cum-fertilizer drills their seed metering mechanism and calibration, Familiarization with planters, Familiarization with transplanters. Familiarization with different inter-cultivation equipment, Familiarization with different types of sprayers, Familiarization with different types of dusters, Familiarization with harvesting machinery, Familiarization with threshing machinery.

Suggested Readings

1. Akshay Krishi Parivar (2022). Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication No.11. pp212.
2. Dakshinkar N.P. and M. Singh, (2022). Draught Animal Power and its relevance to Indian Agriculture. *In:* Bhumi Suposhan, Akshay Krishi Parivar. pp 80-87.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
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5. Pimental D. (1980). Handbook of Energy Utilization in Agriculture, CRC
6. Rahudkar WB (2007). Ancient Agricultural Implements. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 389-396.
7. Rathore NS, Joshi S and Choudhary N (2022). Digital Technologies for Agriculture, NIPA Genx Electronic, Recourses and Solutions Pvt. Ltd.
8. Sahay J (2006). Elements of Agricultural Engineering, Standard Publishers Distributers, New Delhi.
9. Sangwan Satpal. (2007). Level of Agricultural Technology in India (1757- 1857). Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation.pp.397-413.
10. Tillage and Interculture Management/Farm Implements. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

Livestock and Poultry Production 3 (2+1)

Objectives

1. To impart knowledge and skill in rearing of livestock and poultry production
2. To make them aware about basics of livestock and poultry production including managemental aspects under natural farming.

Theory

Historical account of livestock rearing in Vedic, medieval and modern era in India including free range, semi-intensive and intensive systems and major pastoral systems in India, Demographic

distribution and characteristics of livestock (cattle, buffalo, sheep, goat, and poultry) and economy, Common farm management practices of livestock and poultry including housing, feeding, watering, sanitation, pest and disease management, Common vices of animals (cattle, buffalo, sheep, goat), their prevention and care. General principles of sewage disposal and purification, Solid and liquid manure management, Compost making. Ventilation requirements, Presumptive standards for permissible air pollution in buildings, Respiratory exchange in domestic animals, Importance and method of ventilation, Livestock and poultry rearing and carbon footprints, Breeding strategies and biotechnological tools for the improvement of dairy cattle, buffalo, sheep, goat, swine and poultry, Natural breeding for livestock and poultry, Methods of conservation – Livestock and poultry conservation program s in the state and the country, Fodder production and conservation - Importance of grasslands and fodder in livestock production and their management, Structures for storage of feeds and fodders, Scarcity fodders and preservation of green fodder, Recycling of animal shed washings and wastes in fodder production and use of recycle waste., Disposal, utilization and recycling of waste, etc. Sheep, goat, rabbit farming and swine farming: role and importance in natural farming, Classification of poultry with respect to production characters, age and standards, Production characters of other avian species, Description of indigenous fowls and their value in rural farming, Livestock production management - Housing systems, layout and design of different buildings for animals, Selection of site: General principles affecting the design and construction of building for housing for various livestock species. Scavenging system of management – Low input technology, backyard and semi- intensive units; their management and economic achievements.

Deep litter management – Control of litter-borne diseases and recycling of litter, Cage management – Different types; Advantages and disadvantages. Management of growers, layers, broilers and breeders, Stress management.

General management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals. Systems of feeding, restricted feeding, phase feeding. Unconventional feed ingredients -Herbal Bio enhancers.

Protection and welfare of livestock, poultry and working animals. Draught ability of cattle and buffaloes; Routine animal farm operations and labour management, Animal farm accounts and records.

Indigenous technical knowledge related to livestock rearing and veterinary practices, Indigenous technical knowledge pertaining to health and management of livestock.

Classification of poultry with respect to production characters, age and standards; Description of indigenous fowls and their value in rural farming, Specific strains developed for rural poultry production their acceptability and importance in rural eco-system.

Brooding management – Types of brooders, preparation of shed, Importance of environmental factors; Housing – Types of poultry houses, space requirements. Feeding management– Classification of nutrients, Nutrient requirements and feed formulations, Feeding systems; Water management.

Sheep and goat farming: Introduction and scope in the country, Important breeds (exotic and indigenous) and their characteristics, Housing and feeding. Management of sheep and goat for optimal production.

Principles of disease and pest management, Ayurvedic, homeopathic, ethno-medicines, General principles of medication for livestock and poultry in natural farming.

Candling, sexing, grading, packing and disposal of hatchery waste. Trouble shooting hatchery failures, Poultry waste management, pollution and environmental issues, mixed and integrated poultry farming under natural landscape. Vertical and horizontal integration in poultry production, Management of ducks, turkeys, Japanese quails and guinea fowls.

Practical

Identification of indigenous breeds of livestock, small ruminants and poultry and other avians. Acquaintance with natural livestock farms (dairy and small ruminant), backyard poultry and other avians, Layout plans for different livestock houses and poultry, Fodder production and conservation: Visit to the fodder farm, Familiarization with various types of fodders in the states and India. Livestock waste utilization and recycling/ Familiarization with various fertilizers and manures. Human handling and restraining of cattle, buffalo, sheep and Goat: clipping, shearing, dipping, spraying and spotting sick animals, Determination of body weight using different measurements, Training of breeding males: detection of heat, Identification and care of pregnant animals, Care of neonatal and young stock, Diagnosis, prevention and treatment of important diseases and pests of livestock, small ruminants and poultry and other avians, Economic traits of broilers, egg-type chicken and breeders, Poultry farm and hatchery equipment, Brooding arrangement in broiler farms, ITKs related to livestock management, Vaccination, deworming and medication of birds, Keeping records and their maintenance, Feed ingredients and its quality assessment, Fundamentals in poultry post-mortem examination for sample collection and dispatch. Economics and preparation of project report for establishing livestock, fodder and poultry farms/festivals related to animals, Participation and documentation of the region-specific festivals related to animals.

Suggested Readings

1. Banerjee, G.C. 2019. A Textbook of Animal Husbandry. (8th Ed.). oxford and IBH Publishing, New Delhi
2. Chander Mahesh Chander and B. Subrahmanyeswari, B. 2017. organic Livestock Farming, Published by Indian Council of Agricultural Research, 2017
3. Chatterjee, B.N., and Das, P.K. 1989. Forage Crop Production. oxford and IBH Publishing Co.
4. Dakshinkar, N.P. and Singh, M. 2022. Draught Animal Power and its Relevance to Indian Agriculture. In: Akshay Krishi Parivar, Bhumi suposhan: commemorative publication of the nationwide bhumi suposhan and samrak shanjan abhiyan. Akshay Krishi Parivar Publication Number 11. pp. 80-87.
5. Ghotge, N.S. 2004. Livestock and Livelihoods, the Indian Context. Foundation Books, New Delhi.
6. ICAR. 2022. Handbook of Animal Husbandry, ICAR New Delhi.
7. Mission Unit, Division of Agricultural Extension, ICAR, New Delhi. (2003). Veterinary and Animal Husbandry. Inventory of Indigenous Technical Knowledge in Agriculture (Document 1, Document 2 (Supplement 1 and 2) and Document 3). ICAR, New Delhi.
8. Sreenivasaiah, P.V. 2006 Scientific Poultry Production – A unique encyclopedia, 3rd edn.
9. Uprit, S. 2022. Livestock Dung Based Model Sustainable Agriculture through Healthy and Enriched Soil. In: Akshay Krishi Parivar, Bhumi Suposhan: Commemorative publication of the

nationwide bhumi suposhan and samrak shanjan abhiyan. Akshay Krishi Parivar Publication Number 11. pp. 88-96.

10. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR New Delhi

Management of Plant Diseases 2 (1+1)

Objectives

1. To teach students the important plant diseases and plant pathogenic organisms.
2. To impart practical knowledge on crop loss assessment and disease management methods under natural farming.
3. To impart practical knowledge on the preparation of inputs for the management of plant diseases under natural farming.

Theory

Plant disease management under natural farming: Causes / factors affecting disease development, Disease triangle and tetrahedron and classification of plant diseases, Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes , Pathogenesis, Koch's postulates, Role of enzymes, toxins and growth regulators in disease development, Defense mechanism in plants, Epidemiology: Factors affecting disease development, survey, surveillance and vigilance, Crop loss assessment and models, Principles and pre-requisites of forecasting of diseases, Principles and methods of plant disease management, Symptoms, etiology, disease cycle and management of major diseases of field crops and horticulture crops, Methods of plant disease control: Host plant resistance, cultural, mechanical, physical, legislative, biological control, Ecological management of crop environment, Role of soil microbiome in disease management, Suppressive soils, concepts and potentialities for managing soil borne pathogens, Application of khatti lassi, jungle ki Kandi, sontha aster for the management of various types of diseases, Plant growth promoting rhizobacteria (PGPR) and their use in plant protection, Heritage perspective of plant protection (Drumraksha), Plant Protection through Botanicals, ITKs related to management of plant diseases.

Practical

Acquaintance with various laboratory equipment and microscopy, Collection and preservation of disease specimens, Preparation of media, isolation and Koch's postulates, General study of different structures of fungi, Study of symptoms of various plant diseases, Study of representative fungal genera, Staining and identification of plant pathogenic bacteria, Transmission of plant viruses, Study of phanerogamic plant parasites, Preparation of extracts of natural plant products as fungicides, Field visit for the diagnosis of field problems, Collection and preservation of plant diseased specimens for Herbarium, Preparation of pressed and well mounted specimens, Preparation and methods of application of Khattilassi, Jungle ki Kandi, Sontha aster for disease management, Bio-surfactants and their use.

Suggested Readings

1. Alexopoulos, C. J. C.W. Mims, and M. Blackwell. 2007. Introductory Mycology. 4th edn, Wiley India Pvt. Limited,880p.
2. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture. Nene YL. Ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
3. George N. Agrios. 2006. Plant Pathology 5th edn. Elsevier
4. James B. Sinclair and onkar Dev Dhingra. 1995. Basic Plant Pathology Methods. 2nd edn, CRC Press, 448p.
5. Nene YL. 2007. Plant Pathology in India Prior to Twentieth Century. Nene YL. Ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
6. Pest and Disease Management. Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publication - ICAR, New Delhi.
7. Saharan, B. S. and V. Nehra. 2011. Plant growth promoting rhizobacteria: A critical review. Life Sci Med Res.21(1): 30.
8. Saharan, B. S., R. K. Sahu, and D. Sharma. 2011. A review on biosurfactants: Fermentation, current developments and perspectives. Genetic Engineering and Biotechnology Journal, 1-14.
9. Singh R.S. 2017. Introduction to Principles of Plant Pathology. 4th edn CBS Publishers and Distributors, 416p.

Biodiversity Conservation 2 (1+1)

Objectives

1. To impart knowledge on biodiversity in different agro-ecological zones
2. To develop skills on assessment of biodiversity, procedures of biodiversity valuation and strategies of biodiversity conservation.

Theory

Definition, Genetic diversity, Species diversity, Ecosystem diversity: Structural and functional aspects. Agro ecological zones in India with a brief understanding of diversity in soil types, temperature, rainfall, watershed atlas of India, Seasons and season cycle in India, Festivals and seasons, Importance of local biodiversity, Bio-geographic classification of India, The value of biodiversity and conservation, India as a mega diversity nation, Hotspots of biodiversity: criteria for determining hot spots, Threats to biodiversity- habitat loss, pollution, species introduction, global climate change, overexploitation, poaching. Rare species, Extinction: mass extinction, extinction processes, Human factors: social, economic, political and remedial actions, Endangered and endemic species of India, common plant species, common animal species, Conservation of biodiversity- strategies for conservation: i*n-situ* and *ex-situ* conservation, Conservation practices in India and world- organizations involved in resource conservation: IUCN, WWF, UNEP, UNESCO, Biodiversity International, IPGRI, FAO, BSI, ZSI. General account on activities of DBT, BSI, NBPGR, ZSI, FSI, NBFGR and NBAGR NFPTCR, Sacred groves, Biodiversity register, Conservation of biodiversity, Salient provisions of Biological Diversity Act, 2002, Role of Gramsabha

in biodiversity conservation, Ancient Indian culture in biodiversity conservation, Role of biodiversity in SDGs, Ecological economics, Mission Life Style for Environment (Mission LiFE).

Practical

Field survey for studying plant species diversity in a village/region, Study of the morphology and reproductive structures of the types of micro-flora and micro- fauna, Staining of fungal filaments by Cotton Blue, Methylene Blue, Preparation of sterilization media, principles of isolation, pure culturing, Collection, identification and submission of non-wood forest products, Visit to forest to study genus/species distribution, Notes on pest and diseases of forest plants (any four), Study of ITKs on biodiversity conservation and documentation of tangible and non-tangible benefit of biodiversity conservation, Orientation about biodiversity register and its activities.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
2. Dubey, R. C. and Maheswari, D.K. (2010). A Text book of Microbiology, S. Chand and Company, New Delhi.
3. Gadgil, M., and Seshagiri Rao, P. R. (1998). Nurturing biodiversity an Indian agenda. Ahmedabad: Centre for Environment Education.
4. Krishnamoorthy, K.V (2004) An Advanced text book on Biodiversity- Principles and Practice: oxford and IBH publishing company Pvt. Ltd. New Delhi. 10
5. Krishnamurthy, K.V. (2003). Text Book on Biodiversity, Science Publishers, New Hampshare.
6. Puri, GS, Gupta RK, Meher-Homji VM, Puri S. (1989). Forest ecology. Volume 2. Plant form, diversity, communities and succession. oxford& IBH Publishing Co. Pvt. Ltd., New Delhi
7. Sayan Bhattacharya (2014). Forest and biodiversity conservation in ancient Indian culture: A review based on old texts and archaeological evidences. International Letters of Social and Humanistic Sciences. pp35-46.
8. Shahid N., Daniel E. Bunker, A.H., Michel L. and Charles Perrings (2009). Biodiversity, Ecosystem Functioning, and Human Wellbeing: An Ecological and Economic Perspective, oxford University Press, New York.
9. Sharma P.D. (2003). Ecology and Environmental Sciences, Rastogi Publications, Meerut, India
10. Trivedi, P. C. (2007). Global Biodiversity status and conservation. Pointer publishers Jaipur India.

Physical Education, First Aid, Yoga Practices and Meditation 1 (0+1)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory &Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Skill Enhancement course 2 (0+2)

One Course of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

1. To acquaint students with the significance of environmental principles and remediation procedures
2. To develop skills among students on environmental impact assessment

Theory

Multidisciplinary nature of environmental studies: Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems, (a) Forest resources: Use and over- exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people, (b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, (c) Mining resources: Use and exploitation, environmental effects extraction and using mineral resources, case studies, (d) Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, (e) Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy sources, case studies, (f) Land resources: Land as resources, land degradation, man induced landslides, soil erosion and desertification, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles. Ecosystem: Concept of ecosystem, structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristics features, structure and function of the following ecosystems: (a) Forest ecosystem, (b) Grassland ecosystem, (c) Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: Introduction, definition genetic, species and ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social ethical, aesthetic and option values. Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife, man-wildlife conflicts. Endangered and endemic spices of India. Conservation of biodiversity: In–situ and Ex-situ conservation of biodiversity.

Environmental pollution: Definition, cause, effects and control measures of: (a) Air Pollution, (b) Water Pollution, (c) Soil Pollution, (d) Marine Pollution, (e) Noise Pollution, (f) Thermal pollution e.g. nuclear hazards. Solid Waste Management: causes, effects, and control measures of urban and industrial wastes, Role of an individual in prevention of pollution.

Social issues and the environment: From Unsustainable to sustainable development, urban problem related to energy, water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Dies, Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation, public awareness.

Human Population and the Environment: Population growth, variation among nations, population explosion, Family welfare Program, Environment and human health: Human Rights, Value Education, HIV/AIDS, Women and Child welfare, Role of information technology in environment and human health.

Disaster Management: Natural Disaster: Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, climatic changes: global warming, sea level rise, ozone depletion. Man Made

Disasters-Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road, rail, air and sea accidents.

Disaster Management: Effect to migrate natural disaster at national and global levels, International strategy for disaster reduction, Concept of disaster management, national disaster management framework, financial arrangement, role of NGOs, community-based organization and media, Central, state, district and local administration, Armed forces in disaster response, Disaster response, Police and other organizations.

Suggested Readings

1. Environmental Science by Dr Y. K. Singh, New Age International (P) Ltd.
2. Palanisamy, PN: Environmental Science, 3rd edn, Pearson India.
3. Textbook for Environmental Studies by Erach Bharucha, University Grants Commission.

Semester IV

Elements, Characteristics and Design of Natural Farming Systems 3 (2+1)

Objectives

1. To make students aware about concept, function and design of natural farming as a system approach
2. To train students on different advanced methodologies for analyzing and designing agro-ecological specific natural farming units.

Theory

Natural Farming Systems: Concept, importance, approaches, determinants and characteristics, Strength and weakness of natural farming systems, Ecosystems: Concept and components, System approach and concept for farming systems, natural farming systems and ecosystem analysis, The water cycle, nutrient Cycle and energy cycle, Types of ecosystems: Natural ecosystems and agri-ecosystems, concept and classification of ecosystem services, Concept and elements of natural systems, Classification of farming types (based on geographical condition, levels of technology and external input use, labour, demand of produce, etc.), Subsistence farming, Intensive subsistence and primitive subsistence, Traditional farming, intensive conventional farming, integrated farming, conservation agriculture, eco-agriculture, ecologically intensive agriculture (Sustainable intensifications) biodynamic farming, permaculture, cow based farming, cosmic energy farming, prakritik shaswat yogic farming, natural farming, agnihoter farming (homa farming), astrology and astronomy in agriculture, vastu practices, Important agri-based, horti-based, animal based, agro forestry, aqua farming system models, The prairie model, Natural system models at the basis of mimicry (the rain forest model, the dry forest model, Concept of ecosystem based integration of crops, livestock, horticulture and fish farming as complimentary activities, Traditional integrated farming system models based on natural farming principles, Comparison of natural ecosystems, traditional farming system and modern agriculture, Production syndrome in natural farming, Hypotheses and concepts in designing the natural farming system models (Biodiversity and the mimicry hypothesis, productivity, resilience, equilibrium and stability, Levels of organization for

nature mimicry in agro-ecosystems), Principles for cropping and farming system design based on natural ecosystem mimicry, Steps for development of agricultural systems based on mimicking natural ecosystems, Economic evaluation and comparative analysis of different farming systems and natural systems, optimization methodology: a potential approach for system, natural farming system and ecosystem analysis and design.

Practical

Identification and characterization of different natural and agro-ecosystems in the rainfed, hill and mountain, arid, coastal and irrigated regions, Study on characterization of natural eco-systems and intensive farming system, Study on characteristics of elements of water cycle in natural ecosystem and farming system, Study on characteristics of elements of nutrient cycle in natural ecosystem and farming system, Study on characteristics of elements of energy cycle in natural farming, Comparative biodiversity analysis in natural and conventional farming systems, Calculation of biodiversity index for different farming systems, Designing of cropping/farming and natural farming systems, Study and representation of resource flow and recycling in different farming systems, Budgeting: Farm records and farm book keeping in natural farming system, Cost and profit analysis of different components and whole system, Designing of natural farming systems models in different agro-ecosystems, Designing farming systems/natural farming systems using mathematical tools/optimization methodology.

Suggested Reading

1. Agroforestry: Principles and Practices, A. P. Dwivedi, 2019. oxford IBH Publication.
2. Ahimsak Rishi-Krishi Deshpande Farming Technique. http:// rishikrishi.co.in/index. html
3. Behera, U. K. 2013. A Text Book of Farming Systems. Agrotech Publishing House, Udaipur.
4. Behera, U.K. and France, J. 2022. Farming systems research: Concepts, design and methodology. Advances in Agronomy 177: 1-49
5. Compendium of Success Stories of Natural Farming Publishing Agency: NITI Aayog. 2022. ISBN: 978-81- 953811-4-2.
6. Ikerd, J.E., Agriculture and Spirituality. In: Zsolnai, L. and Flanagan, B. (ed) The Routledge International Handbook of Spirituality in Society and the Professions, Routledge, 2019. 31. Agriculture: Spiritual Foundations for the Renewal of Agriculture by Rudolf Steiner
7. Manna, M. C., Rahman, M. M., Naidu, R., Fazle Bari, A.S.M., Singh, A. B., Thakur, J.K., Ghosh, A., Patra, A. K., Chaudhari, S. K. and Subbarao, A. 2021. organic farming: A prospect for food, environment and livelihood security in Indian agriculture. Advances in Agronomy, 170: 101-153.
8. Minamino Y. 1994. Manifesto of Nature Farming. In the Front of organic Agriculture. Fumin-Kyokai, Tokyo, 195pp.
9. Natural Farming: A Practical Guide by Pat Coleby (2004)
10. Sharma, S. K., Choudhary, R., Jat, G., Chhipa, B. G., Jain, D., Gupta, L., yadav, S. K., Jain, R. K., Verma, A., Trivedi, A. and Jain, P. 2022. Compendium- Natural Farming: Perspectives and Prospects in Changing Agriculture Scenario, ICAR- Centre for Advanced Faculty Training on organic Farming, Directorate of Research, MPUAT, Udaipur 313001 (Rajasthan). Pp 1-419. https://cbp.icar.gov.in/ebook22.aspx

11. Sharma, S. K., Choudhary, R., Ravishankar, N., Jat, G., Sharma, R. K., yadav, S.K. and Jain, R. K. 2022. Natural Farming: Concept, Importance, Scope and Status. Directorate of Research, MPUAT, Udaipur 313001 (Rajasthan). Pp 1-1.
12. The Principles of Spiritual Farming - Volume II by Subash Paleker.

Improvement of Traditional and Underutilized Crops 3 (2+1)

Objectives

1. To gain the knowledge on different types of traditional and underutilized crops
2. To train the students on the methods of improvement techniques.

Theory

Importance of traditional and underutilized crops, Genetic basis of crop Improvement: Laws of inheritance; qualitative and quantitative traits, multiple factor hypothesis, pureline theory, components of phenotypic variance, GXE interaction, heritability, breeder's equation, populations/ landraces/ farmers' varieties/ cultivars, Hardy Weinberg equilibrium and factors affecting it, Assortative and disassortative mating, Difference between self-pollinated, cross pollinated and clonal populations, Important physiological parameters for crop improvement- Photosynthesis, transpiration, water and mineral Details of the Course regulation, Breeding objectives under natural farming systems- Nutrient Use Efficiency, Tolerance to micronutrients, mineral deficiencies and toxicities, Weed competitiveness, Enhanced Interaction with Rhizospheric microorganisms, Multiple disease and insect resistance, Quality, Earliness/ crop duration to suit multiple cropping system and agro- ecologies, Wider adaptability and stability, Broad genetic base / population heterogeneity, High yield, Multipurpose crops- stay green, food, feed, fiber and fuel. Plant breeding techniques: Domestication, introduction, Selection, hybridization; Breeding self-pollinated crops- Pureline selection, mass selection, pedigree selection, mass selection, SSD, backcross breeding, Breeding cross pollinated crops- Population improvement, recurrent selection, composite and synthetic varieties, Improving clonally propagated crops- Clonal selection, Farmer participatory plant breeding. Molecular markers, Marker Assisted Selection (MAS), comparison of MAS vs. Phenotypic selection.

Practical

Study of floral biology of different crops, Hybridization techniques, DUS characterization important land races and traditional varieties of crops, Breeding methods for natural farming, Study of root characteristics of crops grown under natural and other production systems, Learning of techniques of participatory plant breeding, Techniques of conservation of plant genetic resources, PRA for mapping indigenous crops and their characteristics, Seed identification and collection for natural farming systems, Identification of important land races and traditional varieties of crops, Identification of important land races and traditional varieties of fruit crops.

Suggested Readings

1. Chahal, G.S. and S.S. Ghosal. 2019. Principles and Procedures of Plant Breeding.
2. Chopra, V.L. 2004. Plant Breeding. Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
3. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

4. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participa- tory approaches in plant breeding for low-input systems. *Euphytica*. 2008; 160:143–54.
5. Fess TL, Kotcon JB, Benedito AV. Crop breeding for low input agriculture: a sustainable response to feed a growing world population. *Sustainability*. 2011; 3:1742–72.
6. Geographical Indications of Plant Species. *In:* Inventory of Indigenous Technical Knowledge in Agriculture Document 5; Publ: ICAR, New Delhi.
7. Lammerts van Bueren ET, 2002. organic plant breeding and propagation: Concepts and strategies. Ph. D. Thesis, Wageningen University, Netherlands.
8. Lammerts van Bueren, E.T., Jones, S. S., Tamm, L., Murphy, K.M., Myers, J.R., Leifert, C. and Messmer, M.M. (2011). The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review. NJAS - Wageningen, Journal of Life Sciences 580: 193-205.
9. Phillips SL, Wolfe MS. Evolutionary plant breeding for low input systems. J Agric Sci.2005; 143:245.
10. Ranganathan Nithya. 2018. Druma Vichitrikaranam - The Ancient Approach to Plant Mutagenesis, Asian Agri-History, Vol. 22(3): 218-225.
11. Singh A K. 2007. Plant Biodiversity and Agriculture in India: A Historical Perspective.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 493-505.

Agro-Eco System Analysis for Natural Farming 2 (1+1)

Objectives

1. To enhance the knowledge about the concepts, types and tools adopted in agro- ecosystem
2. To study the techniques and strategies adopted in natural farming and as a tool in agro-ecosystem analysis

Theory

Definition of system, system hierarchy, Introduction, and concept of agro- ecosystem, Properties of agro-ecosystem, Types of agro ecosystem analysis, Tools and techniques used in agro-ecosystem analysis, agro-ecosystem analysis and sustainable agriculture, Steps involved in agro-ecosystem analysis, Methodology of agro-ecosystem analysis, Energy flow of agro-eco system analysis, Participatory rural appraisal related terms – RRA, PRA, PLA, PLAM, and philosophy of PRM, Participatory planning framework, Importance of participation, Principles of participatory extension, Participatory technology development process

Practical

Simulated exercise on space related methods, Time related methods, Flow related methods, Documentation of participatory technology development process, conducting agro-ecosystem analysis using PRA tools and techniques in village situation**,** Learn the techniques of action plan development.

Suggested Readings

1. Adhikary. 2006. Participatory Planning and Project Management in Extension Science. Agrotech. Publ. Academy.
2. Agro-ecosystem Analysis for Research and Development by Gordon R. Conway.
3. Handbook and agro-ecosystem analysis and agro-ecological zoning: A tool for district land use planning- NAFR Lao-Swedish Upland Agriculture and Forestry Research Program
4. Singh B.K. 2008. PRA/PLA and Participatory training. Adhyayan Publ. and Distr.

Beneficial Insects 3 (2+1)

Objectives

1. To teach students the role of beneficial insects viz., pollinators, decomposers, predators and parasitoids, soil builders, productive insects
2. To impart knowledge on the beneficial insects used under natural farming

Theory

Ecological understanding of insects in natural farming, Study of their life cycle, population dynamics and interaction with other abiotic and biotic components in a natural farming ecosystem, Decomposers (insects) in natural farming system, Pollinators in natural farming systems: their kinds, types, diversity, conservation and profitable use for enhancing.

Productivity in terms of quality and quantity, Natural enemies of poriferous insect's generalist predators, specific predators, parasitoids (egg, larval, pupal and intermediary), Insects in ecological communities, Insects as food, soil builders and insects of aesthetic value, Promotion of required habitat for friendly insects, Pollinators: Honey -bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and diseases, Bee pasturage, bee foraging and communication, Insect pests and diseases of honey bee, Role of pollinators in cross pollinated plants, Types of silkworms, voltinism and biology of silkworm, Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves, Rearing, mounting and harvesting of cocoons, Pests and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection, Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products, Indigenous technical knowledge on management of insect pests, Knowledge and importance of beneficial insects in ancient India.

Practical

Rearing dung beetles for decomposing organic wastes as manure, Pollinators: Diversity, species richness and their use in enhancing productivity of crops, Natural enemies- diversity: species richness, their conservation in *in-situ* and wherever possible, artificial rearing for using pest management. Collection of beneficial insects, study of life cycle and habitats of beneficial insects, crop wise applications of beneficial insects for pest control.

Suggested Readings

1. Atwal AS. 2001. The World of the Honey Bee. Kalyani Publishers, New Delhi.
2. Bukhari R and Bhatt RA.2022 Fundamentals of Sericulture. Narendra Publishing House,

C-21, Varun Apartment, Sector 9, Rohini, Delhi

3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (Eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India. pp.363.
4. Danstan P. Ambrose. 2018. The Insects: Beneficial and Harmful Aspects, Kalyani Publishers
5. David V. Alford. 2019. Beneficial Insects. CRC Press. 400 p.
6. Graham JM. 2015. The hive and honey bee. Dadant and Sons Publication, USA
7. Mishra RC. 2013. Perspective in Indian Apiculture. Agrobius Publication Jodhpur, India
8. Pradip VJ. 2008. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture and Agriculture Pests and their controls. Discovery Publishing Pvt. Ltd., New Delhi
9. Prasad. T.V. 2019. Handbook of Entomology (4th edn). New Vishal Publications
10. Reddy, A, Anusha, C., Ramprasad, B., Kumar, R and V. Daravath. 2022. Importance of Beneficial Insects in Agriculture. Research Trends in Multidisciplinary Research and Development (pp.7-24). Wiser Publications, Germany.

Quantification and Valuation of Ecosystem Service 3 (2+1)

Objectives

1. To orient the students with basic concepts of ecosystems services
2. To impart skills on quantification and valuation of ecosystem services

Theory

Ecosystem Services (ES)-Meaning, Concept and its importance, Classification of Ecosystem Services - Provisioning, Regulating, Supporting and Cultural services, Basics of natural capital, Quantification of ecosystem services-Direct and Indirect approaches, Valuation of Ecosystem Services and its need, Ecosystem valuation methods-Revealed preference methods: Market pricing, Production function, Hedonic pricing methods, Travel cost method and Random utility models, Stated preference methods-Contingent valuation method and choice modelling, Cost based approaches of Ecosystem Valuation- opportunity cost, Cost of alternatives or substitute goods, Replacement cost method, Methods for obtaining Non- economic Values-Focus groups, Citizens' Juries, Health-based valuation , Q- methodology and Delphi surveys, Payment for ecosystem services (PES), Governance and policy issues in ecosystem services, Challenges in valuation of ecosystem services.

Practical

Ecosystem Valuation methods- Direct and indirect methods of calculation, An overview-Millennium Ecosystem Services (MEA) Assessment, Case studies on payment for ecosystem services (PES), Case studies in Ecosystem Services in India and abroad, Study on Environmental Impact Analysis. Visits to the ecosystem areas (Agro ecosystem, Forest Ecosystem and Aquatic ecosystem).

Suggested Readings

1. Baskaran, R., Cullen, R., and Takatsuka, y. (2009). Estimating the value of agricultural ecosystem services: A case study of New Zealand pastoral farming. Australasian Journal of Environmental Management 16 (2): 103-112.

2. Costanza, R., Cumberland, J., Daily, H., Goodland, R., and Norgard, R. (1997a): An Introduction to Ecological Economics. ISEE, Florida, 275 pp.
3. Costanza, R., d'Arge, R., De groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., and van den Belt, M. (1997b). The value of the world's ecosystem services and natural capital. Nature 387:253-260.
4. https://teebweb.org/our-work/nca/understanding-nca/
5. NAAS. 2020. Payment for Ecosystem Services in Agriculture. http://naas.org.in/ Policy%20 Papers/policy%2094.pd

Agricultural Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Joginder Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali. 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objective

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

SEC-VI

Skill Enhancement Course 2 (0+2)

One Course of (0+2) credits of skill enhancement courses will be offered from indicated list of skill enhancement courses.

Semester V

Post Harvest Management -I 3 (2+1)

Objectives

1. To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage of fruits and vegetables
2. To create awareness about natural preservation methods and hygiene and handling of fruits and vegetables.

Theory

Post-harvest management: Importance of fruits and vegetables, Introduction to post- harvest physiology of fruits and vegetables; Post-harvest losses, Maturity indices, Harvesting methods and collection devices, Unit operations in packaging with emphasis on use of natural products like bee wax, gum Arabic, shellac, xantham gum etc., Environment friendly and safe ripening methods, Post-harvest diseases, Disorders and their management.

Storage techniques: Traditional and modern storage structures: on farm and off farm storage, refrigerated storage, evaporative cool chambers, refrigerated vehicles, Storage techniques for local cultivars seeds.

Value addition: Principles and methods of preservation, natural preservatives, indigenous and traditional preservation techniques, phytochemicals for preservation, FSSAI, BIS, and Codex standards for major processed products from fruits and vegetables Value addition in fruits and vegetables through drying, pickling, jam, jelly, marmalade, preserve (murabba), candy, juice, ready-to-serve, squash, nectar, crystallized products, etc.; minimal processing, Eco-friendly handling and packaging: Use of essentials oils and ecofriendly phytochemicals in postharvest handling; Edible films and coating, eco or bio- based polymeric films used for packaging.

Modified atmosphere packaging, Vacuum packaging, Smart packaging, Active packaging using natural or bio-colours, ITKs for handling and packaging; neem- based products for fruit and vegetable handling.

Practical

Demonstration and use of different harvesting tools, Practical demonstration on packhouse operations, Study of different preservation methods for fruits, and vegetables, Study of weight loss of produce in eco-friendly packaging, Determination of TSS and acidity in fresh and processed products, Determination of ascorbic acid, Determination of sugars, Study of different types of dryers, Study of evaporative cooling system/low cost cooling system/Zero Energy Cool Chamber, Preparation of traditional value-added products from fruits and vegetables, Preparation of jam, Preparation of jelly, Preparation of fruit-based beverages, Preparation of pickles, Study of different packaging materials, Visit to industry/processing unit.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

2. De Freitas, S.T., and Pareek, S. 2019. Postharvest Physiological Disorders in Fruits and Disorders. CRC Press, US.
3. Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of Davis, USA.
4. Pareek, S. 2016. Fresh-Cut Fruits and Vegetables: Technology, Physiology, and Safety. CRC Press, US.
5. Pareek, S. 2016. Postharvest Ripening Physiology of Crops. CRC Press, US.
6. Pareek, S. 2017. Novel Postharvest Treatments of Fruits and Vegetables. CRC Press, US.
7. Srivastava, R.P. and Kumar, S. 2002. Fruit and Vegetable Preservation: Principles and

Practices, 3rd Ed. International Book Distribution Co., Delhi.

8. Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables.Vol. I and II. Indus Publishing Co., New Delhi
9. Wills, R. and Golding, J. 2016. Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables. 6th edn, CABI.
10. Yahia, E.M. 2019. Postharvest Technology of Perishable Horticultural Commodities. United Kingdom: Elsevier.

Bio-resources and Agricultural Waste Management 3 (2+1)

Objectives

1. To impart knowledge on various aspects of biowastes and agricultural wastes for managing as organic amendments in agricultural production system
2. To develop skills on various methods of conversion of decomposable wastes into organic manures

Theory

Introduction to bio-resources and agricultural biomass waste, Classification and characterization of agri and livestock biomass waste, Principles of agricultural waste management: 4R's approach, Potential of recyclable crop residues and its management, In-situ management of agricultural waste, Role of soil and plants in waste management, Impact of agro-waste on soil and plant quality and the environment, Pre-treatment of agricultural wastes, Pre-treatment methods: biological treatment, biological-processes of waste management, Bio- conversion/ bio-decomposition through native microflora biogas generation, operation and management of biogas plants, utilization of biogas and spent slurry, landfill, Farm waste management machinery, Environmental benefit of waste management, ITK information on waste management. Mission Life Style for Environment (LiFE) and Govt. schemes to promote agriculture waste into wealth.

Practical

Visit to various agri-farms, Collection and preparation of agricultural waste samples, Characterization of agricultural waste, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Determination of pH, EC and CEC, Determination of BOD and COD, Nutrient status (N, P, K, and micronutrients) analysis of agricultural waste, Survey of

different agri -waste from livestock, dairy, food processing, fruit and vegetable and agri-chemicals, Study of biogas production process and Study briquetting of agricultural residues and important commercial agri-waste management methods in public and private sector.

Suggested Readings

1. Agricultural Waste Diversity and Sustainability Issues. 2021. Ed(s): Peter Fonu, Charles Mbohwa. Academic Press. pp 187.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
3. Deepthi Reddy, M. Devender, Roja Mandapati. 2018. Agricultural Waste Management ICAR, New Delhi.
4. Shaktawat, M.S., N.C. Aery, M.K. Katewa Mohan Singh, B.N. Swami .2004. Phosphate Rich organic Manure (PRoM).
5. Waste water Management/ Garbage disposal and Management. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 and 2); Document 3; Publ: ICAR, New Delhi.
6. Zainul Akmar Zakaria. 2019. Sustainable Technologies for the Management of Agricultural Wastes (Applied Environmental Science and Engineering for a Sustainable Future.

Medicinal and Aromatic Plants 2 (1+1)

Objectives

1. To impart knowledge on diversity of medicinal and aromatic plants and their utilities
2. To develop skilled manpower on cultivation practices of medicinal and aromatic plants under natural farming system

Theory

General aspects of Medicinal Plants: Definition, history, present and future needs, Introduction of plant parts (fruit, leaves, roots, stem, seeds and their modification), Cultivation and harvesting practices, Processing and storage practices, Marketing of medicinal products, Important Indian medicinal plants, Plant parts used as powder: Identification and utilization of Amla (*Embelica officinalis*), Behra (*Terminalia bellerica*), Harad (*Terminalia chebula*), Turmeric (*Curcuma longa*), Garlic (*Allium sativum*), Bitter guard (*Momordica charantia*), Black plum (*Syzygium cumini*), Fenugreek (*Trigonella foenumgraecum*), Cinnamon (*Cinnamomum verum*), Sarpgandha (*Rauvolfia serpentina*), Black pepper (*Piper nigrum*), Ashwagandha (*Withania somnifera*), Psyllium husk (*Plantego ovata*). Plant parts used as juice/ decoction: Identification and utilization of Amla (*Embelica officinalis*), Ginger (*Gingiber officinalis*), Onion (*Alium cepa*), Bottle guard (*Lagenaria siceraria*), Basil (*Oscimum santum*), Arjun (*Terminalia arjuna*), Neem (*Azadirecta indica*), Gwarpatha (*Aloe vera*), Brahmi (*Bacopa monnieri*), Giloy (*Tinospora cordifolia*), Shankhpushpi (*Convolvulus prostrate*), Bael (*Aegle marmelos*). Plant parts used as Lotion and Ointments: Identification and utilization of Gwarpatha (*Aloe vera*), Fenugreek (*Trigonella foenumgraecum*), Pot marigold (*Calendula officinalis*), Neem (*Azadirecta indica*) Plant Parts Used as Oil: Clove (*Syzygium*

aromaticum), Neem (*Azadirecta indica*), Coconut (*Coccus nucifera*), Nilgiri (*Eucalyptus* sp.). Plant parts used as Surgical Fibres, Sutures and Dressings: Identification and utilization of cotton (*Gossipium* sp.), Jute (*Corchorus capsularis*), Banana (*Musa sp*.). Plant parts used as Poultice: Identification and utilization of Turmeric (*Curcuma longa*), Nilgiri (*Eucalyptus sp*.), Ginger (*Gingiber officinalis*), Garlic (*Allium sativum*), Onion (*Alium cepa*), Dhatura (*Dhatura* sp.), Aak (*Calotropis* sp.), Arandi (*Ricinus communis*).

Practical

Identification of locally available common medicinal plants, Basic preparation of herbal products as kadha, powder (Ex. Neem leaf, moringa leaf, tulsi leaf, giloy, arandana), Juice (Ex. Amla, Aloe vera), Trifala, Chyavanprash, Amla candy, herbal tea, etc. Study and documentation of commercial production of at least five medicinal plants, (Using website/ you Tube). Submission of digital photo album of at least ten medicinal plants with brief description, Cultivation maintenance and reporting of at least five medicinal plants within college campus.

Suggested Readings

1. Atal and Kapoor, Cultivation and Utilization of Medicinal Plants, RRL Jammu Tavi.1982.
2. Brahmvarchas, Ayurved Ka Pran: Vanoshadhivigyan, Vedmata Gayatri Trust, Shaktikunj Haridwar.
3. Chaudhry R. D., Herbal Drug Industry, Eastern Publication.
4. CSIR – Cultivation and Utilization of Medicinal Plants.
5. Dutt Ashwin. An Introduction to Medicinal Plants, Adhyayan Publishers and distributers, 200.
6. Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi.
7. Raphael Ikan, Natural Products: A Lab Guide, Academic Press, 1991, 2nd edition.

Seed Production Technology 3 (2+1)

Objectives

1. To make the students aware about concept of seed and quality of seed
2. Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables
3. To make aware about seed legislation, seed certification standards and seed processing.

Theory

Seed quality: Definition and concept of seed quality, Classification of seeds, Use of biodiversity for seed production, Formal and informal seed production systems. Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables, Seed Physiology: Seed germination, viability, seed dormancy, types and requirements of seed germination, Seed health, quality seed collection from natural farming, Seed legislation, Seed testing, Varietal identification through Grow Out Test and electrophoresis, Biochemical tests and molecular tools, Minimum Seed Certification standards, field standards and seed standards, Seed drying and processing, Orthodox seed and recalcitrant seeds, General principles, stages and factors affecting seed longevity during storage and handling, Seed Village Concepts (seed self

reliance), types and significance of indigenous seed conservation, community seed banks, Seed marketing, Role of WTO and OECD in seed marketing, Seed production, collection, storage and quality control in context with Natural farming, Technology of Seed Health during ancient time, Materials recommended (plant based, animal based) in ancient time for seed treatments, Sample case study of a few farmers initiative on conservation of seed in different states of India, PPVFR Act (2001) and Suo generis plant variety law approach, ITKs in seed storage and seed health as compiled by ICAR.

Practical

Seed production in major self-pollinated crops, Seed production in major cross pollinated crops, Seed production in selected vegetable crops, Seed sampling procedures, Seed testing: Physical purity, moisture test, varietal purity. RPL, germination, viability, Grow out test and electrophoresis, etc. Seedling vigour tests, Seed health tests, Genetic purity test: moisture tests, heterogeneity, Seed certification: Procedure, field inspection, taking of field counts, Preparation of field inspection and seed testing reports, Seed collection and rural improved storages, Visits to seed production farms, seed testing laboratories and seed processing plants.

Suggested Readings

1. Andersen MM, Landes X, Xiang W, Anyshchenko A, Falhof J, Osterberg JT, et al.2015. Feasibility of new breeding techniques for organic farming. Trends Plant Sci. 20:426–434.
2. Borgen A. 2009. Present and future system organization of organic plant breeding, In 1 IFOAM Int. Conference on organic Animal and Plant Breeding, Ed. A Zschoke pp 253- 255. IFOAM, Santa Fe, New Mexico, USA.
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5. Fess TL, Kotcon JB, Benedito AV. 2011. Crop breeding for low input agriculture: A sustainable response to feed a growing world population. Sustainability. 3:1742–72.
6. Mone, S. 2016. A source book on India's organic seeds. The organic Farming Association of India. pp 104.
7. Nene YL. 2007. Seed Health in Ancient and Medieval History and its Relevance to Present Day Agriculture. In. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 533-553.
8. Phillips SL, Wolfe MS. 2005. Evolutionary plant breeding for low input systems. J Agric Sci. 143:245.
9. Singh, B.D. 2018. Plant Breeding-Principles and Methods. Kalyani. Publishers, Ludhiana.

Value Chain Management in Natural Farming 2 (1+1)

Objectives

1. Role and importance of value chains, value chain models
2. Role of Farmer Producer organization in value chains of natural farming

Theory

Concept of agriculture value chain, characteristics of value chain management in natural farming, types of value chains, role and importance of value chains; dynamics of renewable and non-renewable resources, resource scarcity, pricing and valuation of natural resources; good agriculture practices, good manufacturing and good processing practices, Value chain models- Producer driven, buyer driven, facilitated models.

Role of farmer producer organizations in value chains of natural farming products; Market initiation and strategies, organization of value chains, roles and responsibilities of stakeholders of value chain, transportation, logistics and infrastructure, cold chain components, dispute resolutions and arbitration, physical asset collateralization, Quality certification like HACCP and FSSAI standards, Postharvest, quality, and value-added aspects for domestic and export market special economic zones, Theory of storage and Warehouses – Types, classification, advantages and disadvantages.

Practical

Case studies and success stories on natural farming or chemical free farming value chains in India and abroad, environmental resource accounting techniques, visit to special economic zones, identification of value chains for commodities, identification of niche markets for natural farming produces; post-harvest loss assessment.

Suggested Readings

1. Carlson, G.A., Miranowski, J., and Zilberman, D. 1998. Agricultural and Environmental Resource Economics. oxford University Press.
2. Faires, Nicole. 2022. The Ultimate Guide to Natural Farming and Sustainable Living, Skyhorse Publishing, ISBN- 9781634502818.
3. Gulati, A., Ganguly, K. and Harshwardhan. 2022. Agriculture Value Chains in India.Springer open Access Book, India Studies in Business and Economics.
4. Prato, T. 1998. Natural Resource and Environmental Economics. Iowa State University Press.
5. Singh, R., Naik, D. and Feroze, S. M. 2014. Agri-Business potentials in India: Experiences from Hill states. EBH Publishers India136, M.L. Nehru Road, Pan Bazaar, Guwahati-781001.
6. Singh, R., Yumnam, A., Roy, A. and Choudhury, A. 2018. Agriculture Development: Technical and Policy options. Biotech Books 4762-63/23 Ansari Road, Darya Ganj, New Delhi, 110002
7. Sterner, T. 2003. Policy Instruments for Environmental and Natural Resource Management. Resources for the Future, Washington DC.

Renewable Energy Sources 2 (1+1)

Objectives

1. To gain the knowledge on different types of renewable energy sources
2. To understand the importance of renewable energy technology and its applications

Theory

Introduction to energy, Forms of energy, Conservation of energy, Sources of energy and their classification, Energy consumption patterns in India, Concept of renewable energy sources,

Potential of renewable energy sources, Classification of renewable energy sources, Ecological footprint, Carbon footprint. Role of renewable energy in natural farming and its impact on food system, Environment and economy, Solar Energy: Introduction of solar energy, solar thermal energy systems: solar cooker, solar distillation, solar water heater, solar dryer, solar photovoltaic systems and their different types and uses, soil solarization, Biomass Energy: Introduction of biomass, biogas–biogas generation process, types of biogas plants, application of biogas, usage of biogas spent slurry, Biomass Gasification- types of gasifiers, producer gas production and utilization, Introduction to ethanol, biodiesel and hydrogen production process. Wind Energy: Introduction, Traditional practices of wind energy, Wind mills and their applications, Role of renewable energy in carbon mitigation, Energy balance in natural farming, Programs and policies for promotion of renewable energy in India.

Practical

Visit to farms to study different source of energy and their consumption, Study of solar cooker, Study of solar dryer, Study of solar water heater, Study of solar distillation, Study of solar photovoltaic system, Study of biogas plant, Study of biomass gasifier, Study the production process of biodiesel, Study of improved biomass cookstove, Traditional practices of wind energy, Determination of energy balance in natural farming.

Suggested Readings

1. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
2. Kothari DP, Singal KC and Ranjan R (2008) Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., New Delhi
3. Rai GD (2013). Non-Conventional Energy Sources, Khanna Publishers, Delhi.
4. Rai GD (2013). Solar Energy Utilization, Khanna Publishers, New Delhi.
5. Rathore NS and Panwar NL (2021). Biomass Production and Efficient Utilization for Energy Generation. New India Publishing Agency, New Delhi.
6. Rathore NS and Panwar NL (2021). Fundamentals of Renewable Energy, New India Publishing Agency, New Delhi.
7. Seveda MS, Narale PD and Kharpude SN (2021). Bioenergy Engineering, CRC Press, Taylor and Francis Group, UK.
8. Seveda MS, Narale P and Kharpude SN (2021). Advances in Renewable Energy Engineering, Narendra Publishing House, New Delhi.
9. Solanki CS (2008). Renewal Energy Technologies: A Practical Guide for Beginners, PHI Learning.

Natural Farming and Human Health 2(1+1)

Objectives

1. To make the students aware about concept of healthy food, Nutritional garden, Homestead kitchen garden and Nutri smart village
2. To understand the beneficial effects of medicinal crops on health

Theory

Changing lifestyles and food habits of the people over the years, Health and disease statistics of world and India, Food production and requirement vis-à-vis growth in human population in India and World, Need of healthy food, Concept of healthy food, safe food, organic food, green food, pesticide free food, fast food, slow food, Dietary guidelines, Traditional food vis-a-vis modern food and its potential health impact, Food Chain contamination and human health hazards, Deficiency in micro-nutrients by the human and livestock population, Malnutrition, Concept of one health, Traditional food of Indian population: Food and its nutrient content, Traditional diets in Indian and their adequacy- Nutritional value of traditional food, Concept of nutrition and health per acre, Interrelationship between natural farming and human health, Health and nutrition disconnect in the agriculture policy of India, Effect of natural farming on animal reproduction, Nutrients, taste, safety, immune system, antibiotic resistance, antioxidant value and protection of environment, Dietary requirement for Indian population: Current diet and nutrition scenario, Recommended Dietary Allowances (RDA): Food exchange list, food composition database, food composition and food groups, bio- fortification of crops, Criteria for classification of quality and safe food, Human health – Definition and philosophy, concept of health- biomedical, ecological, psychological and holistic, Criteria and qualities of organic and natural food, Comparison of natural and conventionally grown foods: Nutritional and non-nutritional components, bioactive components, their impact on human health, effect of processing on nutritional components, conservation of nutrients in processed foods, Food standards, food laws and labelling of natural foods, Concept of nutritional garden, homestead kitchen garden and nutri smart village. ITKs in human food and nutrition and health, Mission Life Style for Environment (LiFE).

Practical

Physical examination of food, determination of gluten, bulk density, hydration capacity and index, oil absorption capacity, Sensory evaluation and organoleptic evaluation of natural and conventional foods, Analysis of proximate composition in conventional foods and natural farming produce/foods based on available secondary data.

Determination of pesticide residues and heavy metal contamination in foods, Market survey and listing of natural farming foods available in the market, Preparation of nutri- thali, Composition of nutrient in different crop plants, Effect of processing on nutritive value of food, Determination of pesticides load in the food stuffs, Glycemic index of common food, Macro – nutrient and micro – nutrient and their sources, Calorie requirement among different class of population, Balance diet for different class of people, Drinking water standard - Limits of heavy metal content

Suggested Readings

1. Agarwal A and Udipi S (2014). Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
2. AOAC International (2016) AOAC Official Methods of Analysis. 20th Edition, Association of Official Analytical Chemists. Washington DC.
3. Bamji S M, Rao P N and Reddy V (2003). Textbook of Human Nutrition. oxford and IBH Publishing Co Pvt Ltd.

4. Lamuela- Raventós (2019). Organic food and the impact on human health, Critical Reviews in Food Science and Nutrition, 59:4, 704-714, DoI: 10.1080/10408398.2017.1394815
5. Sawhney SK and Singh R (2000). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi. Kalia M (2002) Food Analysis and Quality Control. Kalyani Publishers, New Delhi.
6. Shiva V and Singh V (2011). Health per Acre- Organic Solutions to Hunger and Malnutrition. Navdanya Research Foundation for Science, Technology and Ecology.
7. Shiva V, Shiva M and Singh V (2013). Poisons in Our Food- Links between Pesticides and Diseases, Natraj Publishers, Dehradun.

Fundamentals of Entomology 3 (2+1)

Objectives

1. To teach the students on external morphology and anatomy of different systems of insects
2. To teach the students on classification and identification of insects upto family level

Theory

Entomology in ancient India, Historical classics of modern entomology, Classification of phylum Arthropoda up to classes, Relationship of class Insecta with other classes of Arthropoda, Major points related to dominance of Insecta in animal kingdom. Morphology: Structure and functions of insect cuticle and moulting, Body segmentation; Structure of head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, wing venation, modifications and wing coupling apparatus, Structure and modifications of abdominal appendages, Anatomy of insect systems - Digestive, excretory, respiratory, circulatory, nervous, reproductive and glandular systems, sense organs and tropism and bio-communication in insects, Metamorphosis in insects, Taxonomy – Importance, history and development and binomial nomenclature, Definitions of Bio-types, Sub-species, Species, Genus, Family and Order, Classification of class Insecta up to Orders, basic groups of present days insects with special emphasis to orders and families of economic importance and their distinguishing characters.

Practical

External features of Grasshopper/Blister beetle, Methods of collection and preservation of insects including immature stages, Types of insect antennae, mouthparts, legs, wings, wing venation and wing coupling apparatus, Types of insect larvae and pupae, Dissection of digestive system in insects, Dissection of male and female reproductive systems in insects, Study on characters of orders orthoptera, Dictyoptera, odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Coleoptera, Diptera, Hymenoptera, Neuroptera, and their families of agricultural importance, Identification of major pests of crops.

Suggested Readings

1. Chapman RF. The Insects Structure and Function. Cambridge University Press, The Edinburgh Building Press, Cambridge CB2 @RU, UK.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation

and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.

3. Dhaliwal GS, Singh R, and Jindal V.A .2013. Text book of Integrated Pest Management. Kalyani Publishers.
4. Gillott C. 2005. Entomology, Third Edition, Springer University of Saskatchenam- Saskatoon, Saskatchewam, Canada Springer. P.O. Box 17, 3300 AA Dordrecht, The Netherlands.
5. Kapoor VC.2019. Theory and Practice of Animal Taxonomy and Biodiversity. oxford and IBH Publishing 8th Edition.
6. Richard J. Elzinga.2003 Sixth Edition. Fundamentals of Entomology, Printice Hall of India, New Delhi.
7. South Wood TRE. Henderson PA.2000. Ecological Methods. Black Well Science.

Semester VI

Indian Traditional Knowledge 3 (2+1)

Objectives

1. To equip the students with importance of Indian Traditional Knowledge
2. To develop skill for integration of traditional practices for the benefit of farming community

Theory

Introduction and importance of Indian Traditional Knowledge in agriculture and allied sciences: Definition, Difference between Traditional Knowledge System and Western Science System, Protection of Traditional Knowledge, IPR and other provisions, Indian Traditional Knowledge in Agriculture covering Veterinary and Animal Husbandry, Pest and Disease Management, Grain/ Seed storage, Horticultural Crops, Crops and Cropping systems, Farm implements, Weather forecasting, Soil and water conservation, Soil fertility management, Rain water management, Tillage practices, Fisheries, Post-Harvest Technology, Garbage disposal and management, Wind erosion, Waste water management.

Practical

Case studies on validation of ITKs, Need to revive traditional technologies relevant to the contemporary agricultural scenario, Geographical indications of plant species involved in various ITK's (Pest and disease management, Grain/ Seed Storage, Veterinary and Animal Husbandry and Weather forecasting).

Suggested Readings

1. Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture Document 4. 2004. Published by ICAR, New Delhi. Pp 230.
2. Indigenous Technical Knowledge in Agriculture- Geographical Indications of Plant Species. Document 5. 2004. Published by ICAR, New Delhi. Pp 284.
3. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1. 2002.Published by ICAR, New Delhi. Pp 411.

4. Inventory of Indigenous Technical Knowledge in Agriculture. Document 2. 2003. Published by ICAR, New Delhi. Pp 680.
5. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement1). 2002. Published by ICAR, New Delhi. Pp 226.
6. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement2). 2004. Published by ICAR, New Delhi. Pp 321.
7. Validation of Indigenous Technical Knowledge in Agriculture. Document 3. 2004.Published by ICAR, New Delhi. Pp 505 Details of the Course

Post-Harvest Management -II **3 (2+1)**

Objectives

1. To develop skills for primary and secondary processing, mechanical and biocontrol practices for storage pest management in cereals, pulses and oil seeds
2. To create awareness about natural preservation methods and hygiene and handling of fish and meat

Theory

Physico-chemical and nutritive properties of cereals, pulses and oilseeds, causes of post-harvest losses, traditional and modern storage structures, on farm and off farm storage, bulk and bag storage (especially eco/bio-based bags), Primary processing of cereals, pulses and oilseeds: Cleaning, grading, curing/tempering/conditioning, pretreatments including parboiling, Secondary processing: Drying, size reduction (milling), Oil seed milling: Ghanis, hydraulic presses, expellers, extrusion processing and different types of extruded products (snack, breakfast cereals and weaning foods), bakery and confectionary products, Traditional value-added products (regional products like nuggets/wadi/badi, papad, vermicelli/sevai, etc.), Storage Pest Management: Use of ITKs like oil treatment, ash treatment, bio- control practices for storage pest control of cereals, pulses and oilseeds, Primary processing operations in poultry: Pre-slaughter operations and slaughtering operations for poultry: stunning, icing, grading, blanching, washing, evisceration, beheading, scaling, cutting off fins and belly flaps, steaking, filleting, skinning, deboning (meat-bone separator), mincing of skinned fillets, peeling, deveining, shucking, knobbing, Preservation methods for fish: Preservation of meat and fish by canning, chilling, freezing, marination (pickling), curing, cooking and smoking, dehydration, and biological preservatives (fermentation), etc. Value- added products from fish and meat, Hygienic handling and storage of fish: chilling or icing, refrigeration, pest infestations in stored fishery products, natural means to control pests infestation, Food-grade coatings as processing aids, Integrated pest management.

Practical

Study of physico-chemical properties of cereals, pulses and oils seeds, Determination of gluten content in wheat flour, Study of conditioning of wheat, Milling of wheat and rice by laboratory mill, Study of pre-treatment and milling of pulses, Study of oil expression equipment, Manufacture of value- added products, millets, guar gum and other minor crops, Study of primary processing of fish or meat, Study of preservation methods for fish/meat, Preparation of traditional value-added products from fish/meat, Preservation of meat/fish by freezing, Preservation of meat/fish by curing

and pickling, Preservation of meat/fish by dehydration, Preparation of value-added poultry meat products, Quality evaluation and grading of eggs, Visit to processing facilities.

Suggested Readings

1. Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman and Hall, London.
2. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi.
4. Chakraverty, A.K., 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Cutting, C. L. 2002 Processing and Preservation of Fish. Agro Bios, New Delhi.
6. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
7. Mishra, R. (2022). Handbook on Fish Processing and Preservation. Taylor and Francis.
8. N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
9. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing, 2nd edn. Vikas Publishing House Pvt. Ltd., Noida.
10. Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
11. William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th edn. Food Products Press, NY, USA.

Standards and Certification for Natural Farming 3 (2+1)

Objectives

1. To learn the natural farming standards and certification processes vis a vis other standards and certification in vogue.
2. To impart the methods of certification in natural farming based set of standard practices.
3. To understand the process of quality control of inputs and products in natural farming.

Theory

Scope and procedure of Natural Farming Certification System (NFCS), definitions, Crop production, habitat care, conversion, landscape, seeds and planting materials, diversity in crop production, inputs for soil and fertility management, Insect, pest and weed management, Contamination control, Transition / conversion Period and requirements for transition, Soil and water conservation, collection of non-cultivated material of plant origin forest produces, Livestock production, General requirements, Feed and fodder, Health care, Processing and handling, General

requirement: Ingredients, Processing Methods, Packaging, Labelling, *Processed Products,* Storage and Transport, Marketing, Practices for use in soil preparation, Soil enrichment, practices for seed treatment, pest and disease management, procedure to evaluate natural farming input, Ethical Aspects — Animal welfare and socio-economic aspects, practices to be followed for livestock reared in natural farm, International and national regulations on quality assurance and certification for non-chemical farming systems, ICT enabled certification process.

Practical

Visit to natural farm, formulation of natural farm plan, characterization of farm sources (Investigation) and filling up of application forms for certification, exposure of students with the team certification agency, group discussion on natural farm conversion period and standards requirements, quality assurance and labelling requirement for certification of farm under natural farming standards. Visit of certification agency and learning about management of records and inspections.

Suggested Reading

1. APEDA.2018. National Program for Organic Production- A Training Manual, Ministry of Commerce and Industry, GoI, New Delhi.
2. Natural Farming Standards and Certification, Bureau of Indian Standards, Government of India.

Aqua-based Natural Farming 3 (2+1)

Objectives

1. To acquaint students about natural farming and technologies pertaining to aquaculture and their relationship with farming activities
2. Basic understanding and knowledge on the overall view of the aquaculture sector, how to start aquaculture venture, opportunities and challenges

Theory

Physical, biological and components of aquatic ecosystem, Ecological structure and function of aquatic ecosystem, Organic matter recycling and nutrient cycles, Food web and food chain, Heterotrophic activities, Energy and matter flow in the ecosystem, Eutrophication and pollution. Definition and scope of aquaculture, Global and national scenario, Trends and constraints, Different aquaculture systems and utilization of natural food, pond, pen, enhanced fisheries, Pre- stocking, stocking and post-stocking interventions for primary fish survival and growth, Aquaculture and climate change, Natural productivity and carrying capacity, Secondary and tertiary production, Carrying capacity of aquaculture system and associated factors, Natural food and feeding behavior of fishes and shellfishes: Concept of ecosystem based aquaculture, Integration of crop, live- stock, horticulture and fish farming as complimentary activities, Comparative nutritional value and decomposition of different types of organic wastes on organic productivity, Nutrient values of common animal waste and agro residues as potential manures and biofertilizers, Definition of reservoirs in India: nature and extent of reservoirs, pen and cage culture in reservoir, Health management in aquaculture, Traditional techniques for curing fish diseases and pond management, Probiotics

and bioremediation, Renewable and eco-friendly bio- inputs in aquaculture, Management and conservation natural aquatic ecosystems.

Practical

Identification of important cultivable species, Estimation of carrying capacity, Practices on pre-stocking, Stocking and post stocking management, Growth studies in aquaculture system, Study on waste accumulation in aquaculture system (NH , Organic matter, CO_2), Analysis of certified manure/natural aquaculture inputs, Measurement of important soil and water quality parameters and their correction measures with certified standard materials/inputs, Preparation of artificial feeds using locally available permitted feed ingredients, Identification of different live food organisms and their rearing/culture with standard methods, Case studies on cage and pen culture.

Suggested Readings

1. Adhikari, S. and Chatterjee, D. K. (2008) Management of Tropical Freshwater Ponds. Daya Publishing House.
2. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to7, Indian Council of Agricultural Research, New Delhi
3. Fisheries: In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.
4. Khanna SS, and Singh HR (2014) A textbook on Fish Biology and Fisheries, Narendra Publishing House, New Delhi
5. Martin O (2016) Aquaculture: Farming Aquatic Animals, Latest Edition, Syrawood Publication, USAA
6. Pillay TVR and Kutty MN (2011) Aquaculture: Principles and Practices, Blackwell Publishing, UK
7. Veeranjaneyulu K, Krishnaveni G. and Veerabhadra Rao N (2016). Recent Technologies in Fish and Fisheries, RIGI Publication, Punjab, India
8. Zaman, A. Integrated farming system and agricultural sustainability. New India Publishing Agency- NIPA.

Marketing of Natural Farming Produce 3 (2+1)

Objectives

1. To study about the specific concepts of marketing channels, price spread market segmentation and market margin
2. To develop skill on calculating market margin and farmers share in consumer's rupee in natural farming

Theory

Concepts and definition of market, Agricultural marketing, Marketing of natural farming products, Market structure, Marketing mix and market segmentation, Demand, supply and

producer's surplus of agricultural commodities marketable and marketed surplus, Pricing consideration and approaches cost based and competition based pricing, Market promotion and publicity, Marketing management-segmentation, Targeting and positioning, Marketing function-physical function, facilitating functions, Market functionaries and marketing channels, Marketing efficiency, Marketing costs, Market margin and price spread, Role of government in marketing of natural farming products, Public sector institutions – CWC, SWC, FCI,CACP, APEDA, Risks in marketing-types of risks involved speculation and hedging, Forward markets and Future markets.

Practical

Study of relationship between market arrival and prices, Demand and supply curves, Calculation of marketable and marketed surplus, Identification of market channels for selected commodities, Computation of market margin, Price spread, visit to marketing institutions to study their organization and functioning.

Suggested Readings

1. Acharya S.S. and Agarwal N.L. (1994). Agricultural Price Analysis and Policy, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Acharya, S.S. and Agarwal, N.L. (2000). Agricultural Marketing in India, Oxford and IBH Publishing Co. New Delhi.
3. Kahlon, A.S. and George, M.V. (1985). Agricultural Marketing and Price Policy, Allied Publication Pvt. Ltd. New Delhi.
4. Kohls, Richard L. and Uhl, Joseph, N. (1980). Marketing of Agricultural Products, Macmillan Publishing Co. Inc. New York.
5. Mamoria, C.B. and Joshi, R.L. (1971). Principles and Practices of Marketing in India, Kitabmahal, Prayagraj.
6. Meena G.L. Burak SS, Pant DC, and Sharma R. (2017). Fundamentals of Agribusiness Management, Agrotech Publishing Academy, Udaipur, ISBN: 978-81-8321-418-6. First Edition.

Agronomic Practices 2 (1+1)

Objectives

To acquaint students with management aspects of crops, weeds, water in natural farm fields

To develop skills among students in practicing crop husbandry based natural farming

Theory

Classification of crops, Field crops – Origin, distribution, economic importance, soil and climatic requirements, varieties, cropping systems: definition, principles and its importance, physical resources, soil and water management in cropping systems, Importance of mixed cropping in natural farming, multiple cropping, alley cropping, sequential cropping and intercropping, cropping system indices - mechanism of yield advantage in intercropping systems, Complementary and competition relations, multi-storied cropping and yield stability in intercropping, Types of crops - Trap, cover, catch and restorative crops, ITK related to crops

and cropping systems, Seeds- Traditional and recent varieties, classification of seeds, seed dormancy, nursery management, main field preparation, types of tillage, Seasons of India, Pre-monsoon sowing, Sowing techniques, Optimum time of sowing for different crops-ITK for seed treatment and seed selection, Methods of planting of crops,Time of planting of different crops and intercrops, Row spacing for different crops, Irrigation– Definition, irrigation types, water saving techniques and management, ITKs in irrigation and water management, Green manures and green leaf manures – Types of green manures, Ideal plant types for green manures, Nutrient content and biomass contribution, time and method of incorporation, decomposition pattern, Advantages and limitations, Weeds- Classification, habitat management of weeds, crop weed interaction, critical periods of weed competition, non-chemical weed management, weed mulch, trap crop, biological and herbal measures, Mulching – Types, cover crops – advantages and disadvantages, Soil moisture conservation approaches and water harvesting, ITKs on soil and water conservation. Alternate land use system – Definitions and types.

Practical

Identification of different growth stages in crops, manures and seeds, agriculture tools and implements, nursery and main field preparation, animal drawn, seed treatment and seed dormancy, methods of sowing, input requirement, water requirement and water use efficiency (WUE), weeds in wetland, irrigated up land, dryland system, low cost technology, indices for cropping systems, mulching practices, green manuring practices, alternate land use system, wind break and shelter belt, ITKs in crops and agronomic practices.

Suggested Readings

1. Chandsrasekaran B. and E. Somasundram (2018). A Text book of Agronomy, New Age International Publication, New Delhi.
2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
3. Crops and Cropping Systems/ Soil and Water Management/ Rain water management. In: Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publ: ICAR, New Delhi.
4. Das, P., Das, S.K., Arya, H.P.S., Reddy, G. Subba, Mishra, A. and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission Mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 to 7, Indian Council of Agricultural Research, New Delhi.
5. Dwivedi A. P. (2019). Agroforestry Principles and Practices, Oxford and IBH Publication.
6. Reddy S. R. (2020). Principles of Agronomy, Kalyani Publications. New Delhi.
7. Reddy T. Yellamanda and G. H. Shankara Reddy (2016). Principles of Agronomy, Kalyani Publications, New Delhi.
8. Somasundaram E. and M Mohamed Amanullah (2017). Agronomy: Principles and Practices, New India Publishing Agency, New Delhi.

Intellectual Property Rights 1 (1+0)

Objectives

1. To acquaint the students about filing of patent, patent specification, patent claims, Patent opposition and revocation
2. To create awareness in the students about infringement, compulsory licensing, patent search and patent database

Theory

Introduction, importance and meaning of intellectual property, changing scenario of agriculture in India, brief introduction to GATT, WTO,TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.; Types of Intellectual Property and legislations covering IPR in India: Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets, Patents Act, 1970 and patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database: Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant Breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researchers and farmers rights, Traditional knowledge-Meaning and rights of TK holders. Convention on biological diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA), Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing. Understanding Intellectual Property Rights in ancient India.

Suggested Readings

1. Chawla H.S. 2020.Introduction to Intellectual Property Rights. Oxford and IBH Publ. pp312. 4. P.C. Sinha. 2007.
2. Encyclopedia of Intellectual Property Rights. Anmol Publications Pvt. Ltd.
3. Sridevan Prabha. 2015. Intellectual Property in the Ancient Indian Texts. In: Diversity in Intellectual Property.pp.232-246. Publ: Cambridge University Press.
4. Verma Deepak and Madhu Bala. 2020. National Intellectual Property Rights Policy of India - A Review. In: Sensitizing and Imparting Awareness about Intellectual Property Rights among Students (pp.125-132). Publisher: National Press Associates.

Principles of Agricultural Economics and Farm Management 2 (2+0)

Objectives

1. To impart knowledge on judicious use of resources for optimum production
2. To impart knowledge about basic theories of demand, supply, production and exchange.

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis: micro and macroeconomics, positive and normative analysis, Nature of economic theory: rationality assumption, concept of equilibrium, economic laws as generalization of human behavior,

Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare, Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development, Agricultural planning and development in the country, Demand: Meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle, Consumer's equilibrium and derivation of demand curve, concept of consumer surplus, Elasticity of demand: Concept and measurement of price elasticity, income elasticity and cross elasticity, Production: process, creation of utility, factors of production, input output relationship, Laws of returns: Law of variable proportions and law of returns to scale, Cost: Cost concepts, short run and long run cost curves, Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply, Distribution theory: meaning, factor market and pricing of factors of production, Concepts of rent, wage, interest and profit, National income: Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement, Population: Importance, Malthusian and Optimum population theories, natural and socio-economic determinants, current policies and program s on population control, Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, money supply, general price index, inflation and deflation, Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning, Forms of business organizations, international trade and balance of payments, GST and its implication on Indian economy.

Suggested Readings:

1. Ahuja H.L. (2011). Principles of Microeconomics by. S. Chand and Company Ltd., New Delhi
2. Johl, S.S and T.R Kapur. (2009) Fundamentals of Farm Business Management. Kalyani Publishers, New Delhi
3. Meena G. L. (2022). Fundamentals of Agricultural Economics. Lucky Publishing House, Udaipur
4. Reddy S. Subha, P. Raghu Ram, T.V. Neelakanta and I. Bhvani Devi (2004) Agricultural Economics. Oxford and IBH publishing Co. Pvt. Ltd
5. Sharma L., Acharya S. K. and Somani S. S. (2015). Principles of Agricultural Economics. Agrotech Publishing House, Udaipur.

Semester VII

Community Mobilization for Natural Farming 2 (1+1)

Objectives

1. To gain the knowledge about the fundamental concepts and principles of community mobilization, program planning and about groups
2. To develop an understanding of techniques and strategies for community mobilization in natural farming

Theory

Community mobilization – Meaning, historical background, types, strategies, steps, opportunities and challenges, Community mobilization process: community mobilization in

rural areas and different models, community entry, profiling, social mapping, Yoga for community mobilization - Purpose, concepts, importance, types, benefits; SWOT Analysis- Meaning, advantages and case study, Social core value systems - Ethical principles, purpose, benefits, Development of understanding about rural society, Behavioral change and attitude, Program planning - Introduction, need and interest, concept, objectives and principles, process, Organizational structure - Define, key elements, types, span of control, Centralization and decentralization, formalization. Diffusion and Adoption Process- Define, meaning and stages.

Group: Definition, types, stages of group formation, modes of group development, process for group formation - stages of SHG, FPO/FPC and FBO development, group decision making techniques, FPO - benefits, activities, implementing agencies to form and promote FPOs, procedure to form FPC and organizational structure, Conflict -Meaning, types, process, conflict resolution and management strategies.

Motivation: Definition, elements, individual and group needs, motivation process, Maslow's Hierarchy theory of needs and Adam's Equity theory, motivation cycle, classification of motives, types of motivation, techniques of motivation, role/importance/factors of motivation. Capacity building and institutionalizing mechanism, Counselling – Need, functions and types, Mentoring: Definition, process, philosophy and mentor-mentee relationship, Training - meaning, advantages, types and process, training methodologies for creating awareness about natural farming, Monitoring and Evaluation - Define, objectives, types, concept, difference, importance; Impact analysis on social, economic and environmental effects of natural farming.

Case studies on community mobilization in natural farming, Traditional and social media for promoting natural farming, Government schemes and role of public and private institutions in promoting community mobilization in natural farming.

Practical

Preparation of Community Resource Mapping in selected rural villages, Community needs assessment techniques – Participatory Rural Appraisal, Yoga, SWOT analysis, Organization involved in community mobilization, Program planning and organizing events, Formation and functioning of SHG, Establishment, organizational structure and promotion of FPO and FBO, Group decision making techniques - Conduct of focused group discussion, Conflict management techniques, Motivation – preparation of Maslow's hierarchy theory of needs assessment, Counselling and mentoring- conduct sessions among beneficiaries of natural farming community, Organizing, capacity building programs, Socio economic impact analysis on natural farming, Traditional and social media for promoting natural farming, Public and private institutions promoting community mobilization for natural farming.

Suggested Readings

1. Choudhary, S.L., G.S. Sharma and Y.L. Nene (2000). Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
2. Prasad R.R. Community Mobilization – Methods and Models. Discovery Publishing House Pvt. Ltd.

3. Rasheed Sulaiman. V, Onima. V.T, Nimisha Mittal, Athira. E (2019). Taking Stock and Shaping the Future: Conversations on Extension, AESA.
4. Sethuraman S P, Santakki BS, Sulaiman R, Saravanan V,R, Mittal N, 2017. Manual on Good Practices in Extension Research and Evaluation, AESA.

Water Management 2 (1+1)

Objectives

1. To equip the students with the knowledge about the fundamental concepts and principles of water management
2. To develop an understanding of techniques and strategies for conserving water resources and improving water use efficiency both in rainfed and irrigated ecosystems

Theory

History of water management in ancient and medieval India, Rainfed and irrigated farming; Water management: Definition, scope and importance, Water resources: Use and over- utilization of surface and ground water, floods, drought, Dams-Benefits and problems, Region specific traditional water harvesting and management systems, Rainfed farming, Rainwater conservation technologies - In-situ and ex-situ storage, water harvesting and recycling, Rain water harvesting, Farm ponds, Ground water recharge, Contour and graded bunding, *Chalkhal*, Water budgeting, Irrigation water requirement, Micro irrigation: Sprinkler, Drip irrigation systems, pitcher irrigation system, maintenance of micro irrigation system, fertigation, advantages and limitations of fertigation, Watershed management - Concept, objectives, factors affecting and watershed planning, Reservoirs, Ground water harvesting and conservation (Tanka, Talai, Nadi, Nada, Talab, Khadin), Indian Traditional Knowledge in rain water management, soil and water conservation.

Practical

Measurement of soil moisture by different soil moisture measuring instruments, Measurement of irrigation water requirement, Determination of bulk density by field method, Determination of field capacity by field method, Determination of permanent wilting point, Case study on water budgeting, Study of different types of farm ponds, Estimation of farm pond storage capacity, Testing of irrigation water quality, EC, pH and TDS, Study of different components of sprinkler irrigation system, Study of different components of drip irrigation, Field visit to micro irrigation system, Maintenance of different components of micro irrigation systems, Survey of watershed resources, Field visit to watershed, Field visit to water harvesting structure.

Suggested Readings

1. Choudhary ML, Kadam US. 2006. Micro irrigation for Cash Crops, Westville Publishing House.
2. Jat, ML, Sharma SK, Balyan JK, Kothari A K and Jain LK. 2011. Rainfed Farming. Kalyani Publisher, Ludhiana. pp. 324.
3. Michael AM. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Michael AM and Ojha TP. 2014. Principles of Agricultural Engineering. Vol. II 5th edn. Jain Brothers Publication, New Delhi.

5. Mishra Anupam, 2021.Aaj Bhi Khara Hai Talab.
6. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
7. Rajasthan Ki Rajat Bunde.
8. Sadhale Nalini. 2007. Water Harvesting and Conservation in Ancient Agricultural Texts. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp.414-424.
9. Singh Harpal and Kavia ZD. 2007. Traditional Rainwater Harvesting Methods of Indian Thar Desert. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation.pp.432-440.
10. Singh, P.K. 2000. Watershed Management: Design and Practices. E-Media Publications, Udaipur.

Research Methodology and Ethics 2 (1+1)

Objectives

1. To provide basic knowledge on research tools and techniques
2. To develop skills on on-farm research and ethics in general with specific reference to natural farming

Theory

Research Ethics: Introduction, Ethical ethos- Researcher's obligations and participant's rights, Research Ethics: Researcher-Participant, General Ethics, Ethical Issues in India, Ethics Committees. Experimental techniques: Research design, sampling, data collection, On-station experimentation, On-Farm experimentation, tabulation, Statistical tools and analysis, techniques for interpretation of data, Geo-referenced characterization: Questionnaire design principles, Questionnaire design for consumers of organic products, Questionnaire design for farmers and producers of organic products, Questionnaire design for processors/traders/exporters, Geo-spatial analysis and mapping of natural farms/ producers/traders/consumers.

Meta data analysis: Concepts, Niche area and crops for natural farming: Parameters for niche area and crop, Different scales of niche area, Tools and steps in niche area and crop identification, Parameterization and classification based on macro, regional and micro level.

Climate resilience of natural farming: Methodology for identification of climate resilient production systems, GHG's estimation using IPCC, GHG's measurement using instrumentation, Global warming potential, Energy and Carbon budgeting. Bio-chemical and molecular signature of natural produces, Commercial project formulation on natural farming: Internal rate of return, Pay Back period, B:C ratio, Net Present Value, Model project formulation for organic farming, Impact analysis tools and methods, Farming system model development: Practical synthesis of natural farming system model, Estimation of GHG emission from natural farm using IPCC tools, Identification of niche area and crops for a district or block, Identification of climate resilient production system using long term meteorological data, Commercial project formulation, Geo-spatial analysis using GIS platform, Comparative carbon and energy budgeting between organic and natural farms, Comparative food quality between natural and conventional produces by meta-analysis.

Suggested Readings

1. Kamat P.V. Research Ethics. Retrieved from https://www3.nd.edu/~pkamat/pdf/ ethics.pdf.
2. Parveen, Huma and Showkat, Nayeem. (2017). Research Ethics. https:// www. researchgate. net/publication

Weather Forecasting 3 (2+1)

Objectives

1. To provide the knowledge on different types of weather forecasting
2. To acquaint the importance of weather forecasting and its applications
3. To train the students on the ancient weather based agricultural practices

Theory

Ancient wisdom on weather forecasting: Rainfall prediction, analysis and forecast of winter monsoon based on ancient literature and simulated models, Rain forecasting in India Almanacs (Panchangs), Measurement of rainfall, Testing of traditional methods of weather forecast, Ancient astronomers, Indian Almanac (Nakshatras, Rashi, Months, Paksha, Seasons, Tithi, Var, Yog, Karn, Nadi,), Krishi Panchang, Effect of planets on weather, Ancients methods of weather forecast (Analytical methods, Observational methods). Principles of Astro- Meteorology, Rainfall predictions techniques (1) Parashara technique, (2) Varahamihira technique, (3) Predictions based on planets, (4) Bio-indicators, (5) Other ancient rainfall predictions, Sudden rainfall, Indications of famine, The method of ascertaining the type of cloud of the year, Folklore regarding weather forecasting (Ghagh and his wife Bhaddri), (6) ITKs with description and the practitioner for weather forecasting, Meaning and scope of agricultural meteorology, Earth atmosphere-Its composition, extent and structure, Atmospheric weather variables, Atmospheric pressure, its variation with height, Nature and properties of solar radiation, solar constant, depletion of solar radiation, shortwave, longwave and the normal radiation, net radiation, albedo, Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth, Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud, Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet and hail, cloud formation and classification, Artificial rain making. Wind: causes and types of wind, cyclone, anticyclone, land breeze and sea breeze, General circulation; Indian Monsoon - mechanism and importance in Indian agriculture, Weather forecasting - types of weather forecast and their uses, ITK in weather forecasting, Weather hazards-High winds, drought, floods, tornado, frost, tropical cyclones, thunderstorms, dust storm, lightning and hailstorms and extreme weather conditions such as heat-wave and cold-wave, Agriculture and weather relations, Modifications of crop microclimate, climatic normal for crop and livestock production, Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national agriculture, Types of climate models – GCM and RCM.

Practical

Visit of Agrometeorological Observatory, site selection, layout, exposure to instruments and data acquisition techniques, Study and use of different instruments for measuring air temperature, rainfall, Estimation of net short-wave radiation, net long wave radiation, total

global and net radiation, Measurement of albedo and sunshine duration, wind speed and direction, Measurement of evaporation rate using USWB Class A Open Pan Evaporimeter, Determination of relative humidity and vapour pressure, Study and use of Duvdevani Dew Gauge for measurement of Dew, Computation of climatic normal using historical weather data, Study of ancient methods of weather forecast, Preparation of Krishi Panchang, Testing local folklore for weather forecasting.

Suggested Readings

1. Balkundi HV. 2007. Measurement of Rainfall in Ancient India. *In:* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp.365-372.
2. Chandrasekaran, B., K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. New Age International (P) Limited Publishers. pp856.
3. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the Summer School held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
4. Inventory of Indigenous Technical Knowledge in Agriculture. Thematic area: Weather Forecasting. Document 1(2002); Document 2 (2003); Document 2- Supplement 1(2003); Document 2- Supplement 2(2004); Document 3 (2004); Document 4 (2004); Published by ICAR, New Delhi.
5. Kanani PR. 2007. Testing of Traditional Methods for Weather Forecast in Gujarat. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 373-388.
6. Mishra SK, Dubey VK and Pandey RC. 2007. Rain Forecasting in Indian Almanacs (Panchangs): A Case for Making Krishi – Panchang. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 354-364.
7. Murugan M, Miniraj N, Josephraj Kumar A, Pradeep K P and Yusuf L. 2007. Analysis and Forecast of Winter Monsoon Based on Pre-Vedic Literature and Simulated Model. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp. 344-353.
8. Ram Niwas, Surinder Singh, Diwan Singh, M.L. Khichar and Raj Singh. 2006. A Text Book on Agricultural Meteorology. CSS HAU, Hisar.
9. Sharma BD. 2007. Ancient Indian Wisdom on Agriculture and Weather Forecasting. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 323-325.
10. Varshneya MC. 2007. Ancient and Recent Methods of Rainfall Prediction. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri- History Foundation. pp. 326-343.

Basic and Applied Agricultural Statistics 3 (2+1)

Objectives

1. To provide an idea on Statistical concepts of both descriptive and inference Statistics
2. To impart knowledge about tests of significance, ANOVA and sampling theory

Theory

Introduction to Statistics and its applications in agriculture, Types of Data, Scales of measurements of Data, Summarization of Data, Classification of Data, Frequency Distribution, Methods of Classification, Definition of Grouped and Ungrouped Data, Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points, Types of Frequency Distribution, Diagrammatic Presentation of Data, Bar Diagrams – Simple, Multiple, Sub-divided and Percentage Bar Diagrams, Pie-diagram, Graphical Presentation of Data – Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency, Requisites for an Ideal Measure of Central Tendency, Different Types of Measure, Arithmetic Mean– Definition, Properties, Merits, Demerits and Uses, A.M. (examples) for Grouped and Ungrouped Data, Step-deviation Method, Weighted Mean, Definition of Geometric Mean and Harmonic Mean, Relationship between A.M., G.M. and H.M. Median- Definition, Merits, Demerits and Uses, Graphical Location of Median, Mode- Definition, Merits, Demerits and Uses, Graphical Location of Mode, Relationship between Mean, Median and Mode, Measures of Dispersion, Characteristics for an Ideal Measure of Dispersion, Different Types of Measures of Dispersions, Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation, Standard Deviation- Definition, Properties, S.D. and Variance for Grouped and Ungrouped Data, Variance of Combined Series, Coefficients of Dispersions. Co-efficient of Variation, Measures of Skewness and Kurtosis: Definition of Symmetrical Distribution, Definition of Skewness, Measures of Skewness, Definition of Kurtosis, Measure of Kurtosis, Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution, Introduction to Probability, Basic Terminologies, Classical Probability- Definition and Limitations, Empirical Probability- Definition and Limitations, Axiomatic Probability, Addition and Multiplication Theorem (without proof), Conditional Probability, Independent Events, Simple Problems based on Probability, Definition of Random Variable, Discrete and Continuous Random Variable, Normal Distribution- Definition, Prob. Distribution, Mean and Variance, Assumptions of Normal Distribution, Normal Probability Curve.

Correlation and Regression, Definition of Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Types of Correlation Coefficient, Properties of Correlation Coefficient, Definition of Linear Regression, Regression Equations, Regression Coefficients, Properties of Regression Coefficients.

Tests of Significance, Definition, Null and Alternative Hypothesis, Type I and Type II Error, Critical Region and Level of Significance, One Tailed and Two Tailed Tests, Test Statistic, One Sample, Two Sample and Paired t-test with Examples. F-test for Variance.

ANOVA and Experimental Designs, Definition of ANOVA, Assignable and Non assignable Factors, Analysis of One-way Classified Data, Basic Examples of Experimental Designs, Terminologies, Completely Randomized Design (CRD).

Sampling Theory, Introduction, Definition of Population, Sample, Parameter and Statistic, Sampling Vs Complete Enumeration, Sampling Methods, Simple Random Sampling with Replacement and without Replacement, Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data, Calculation of A.M., Median and Mode (Ungrouped and Grouped data), Calculation of S.D. and C.V. (Ungrouped and Grouped data), Correlation and Regression analysis, Application of t-test (one sample, two sample independent and dependent), Analysis of variance one way classification, CRD, Selection of random sample using simple random sampling.

Suggested Readings

1. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
2. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
3. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishes.
4. Basic Statistics by B. L. Agarwal, New Age International Publishers.
5. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
6. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.

Semester VIII

S. No.	Course Title	Credit Load
1.	For students opting for 4-year B. Sc. Ag. (Hons.) Natural Farming degree Based on the theme of Student READY Program, students may be allotted Experiential Learning/Hands on Training/Skill development/ RAWE/ Industrial attachment/IPT/ student project and Internship depending upon the resources and priorities. RAWE Experiential Learning IPT/Industrial Attachment Student Project/Internship	20 Credits (Minimum 20 weeks) 8 6 4 2

For B.Sc. Ag. (Hons.) Natural Farming

- Project work: Student Project will be either R&D based, field study based (RAWE) or entrepreneurship based (incubation/experiential learning). The project work will be of above mentioned credits (Minimum 20 weeks) during which they will be attached to projects to learn, field experience, laboratory and field research or incubation centres or experiential learning units for developing viable projects.
- Internship work: The students will be attached to industry/ research institute/ commercial farm/ NGO/ agribusiness entrepreneur for 10 weeks with 10 credits to complete internship work and to learn entrepreneurship skills.
- Each student will submit individual report for both project work and internship work which will be evaluated and given grades.

ELECTIVE COURSES

S. No.	Course Number	Title
1.	Ag Econ (E) 413	Agri-Business Management
2.	Agron (E) 413	Management of Natural Resources

S. No.	Course Number	Title
3.	EE (E) 413	Agricultural Journalism
4.	Hort (EA) 323	Landscaping
5.	GPB (E) 413	Commercial Plant Breeding
6.	Hort (EB) 323	Food Safety and Standards
7.	PP (EA) 322	Bio Formulation and Nano formulation
8.	PP (EB) 413	Biopesticides and Biofertilizers
9.	Ag Met (EA) 413	System Simulation and Agro-advisory
10.	Hort (EC) 413	Hi-tech Horticulture
11.	Hort (ED) 413	Protected Cultivation
12.	Ag Met (EB) 413	Climate Resilient Agriculture
13.	ABT(E) 413	Biotechnology of Crop Improvement
14.	Soil (E) 412	Geoinformatics and Remote Sensing, Precision Farming
15.	Hort (EE) 413	Micro-propagation Technologies
16.	SST-413	Commercial Seed Production

- More electives to be included by the universities / institutions, based on the facilities available, such as nano formulations, drones use in agriculture etc

Agri-Business Management 3 (2+1)

Objective

To impart knowledge on understanding the concepts processes, significance and role of management and organizational behavior

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems, Importance of agribusiness in the Indian economy and New Undergraduate Degree Program in Natural Farming

Agricultural Policy, Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro-based industries, Institutional arrangement, procedures to set up agro-based industries, Constraints in establishing agro-based industries, Agri-value chain: Understanding primary and support activities and their linkages, Business environment: PEST and SWOT analysis, Management functions: Roles and activities, Organization culture, Planning, meaning, definition, types of plans, Purpose or mission, goals or objectives, strategies, polices procedures, rules, programs and budget, Components of a business plan, Steps in planning and implementation, Organization staffing, directing and motivation, Ordering, leading, supervision, communications, control, Capital management and Financial management of Agribusiness, Financial statements and their importance, Marketing Management: Segmentation, targeting and positioning, Marketing mix and marketing strategies, Consumer behavior analysis, Product Life Cycle (PLC), Sales and Distribution management, Pricing policy, various pricing methods, Project management: Definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation, Project appraisal and evaluation techniques.

Practical

Study of agri–input markets: Seed, fertilizers pesticides, Study of output markets: grains, fruits, vegetables, flowers, Study of product market, retails trade commodity trading, and value added products, Study of financing institutions- Cooperative, Commercial Bank, RRBs, Agribusiness Finance Limited, NABARD, Preparations of projects and Feasibility reports for agribusiness entrepreneur, Appraisal/ evaluation techniques of identifying viable project- Non-discounting techniques, Case study of agro- based industries, Trend and growth rate of price of agricultural commodities, Net present worth technique for selection of viable project, Internal rate of return,

Suggested Readings

1. Bairwa SL, 2016. Objective on Fundamentals of Agri-business Management. Kalyani Publishers.
2. Broadway AC, Broadway Arif A, 2002. A Textbook of Agri-Business Management. Kalyani Publishers.

Management of Natural Resources 3 (2+1)

Objective

1. To enlighten students about available natural resources and their relationship with crop production
2. To impart the knowledge of principles and practices of natural resource management

Theory

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources, Factors influencing resource availability, distribution and uses, Interrelationships among different types of natural resources, Concern on productivity issues, Ecological, social and economic dimension of resource management, Land resources: Land as a resource, Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification, Landscape impact analysis, wetland ecology and management, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water ecology and management, Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources, Resource Management Paradigms: Resource management the evolution and history of resource management paradigms, Resource conflicts: Resource extraction, access and control system, Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches: integrated resource management strategies, Introduction to soil and water conservation and causes of soil erosion, Definition and agents of soil erosion, Water erosion: Forms of water erosion, gully classification and control measures, Soil loss estimation by universal soil loss equation: Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping, Contour bund: Graded bund and bench terracing, Wind erosion: Mechanics of wind erosion, types of soil movement, Principles of wind erosion control and its control measures, Water harvesting techniques: Lining of ponds, tanks and canal systems.

Practical

Identifying natural resources and their utility, Practicing survey: Principles and educating to use pacing technique for measurement, Area calculations through chain survey: GPS demo for tracking and area measurement, Estimation of soil loss and calculation of erosion index, Leveling concepts

and practical utility in agriculture, Preparation of contour maps, Concept of vegetative water ways and design of grassed water ways, Wind erosion and estimation process, Different irrigation pumps and their constructional differences, Farm pond construction and its design aspects, Visit to nearby farm pond, Visit to an erosion site, Exposure to strip cropping/contour bunding.

Suggested Readings

1. Management of Natural Resource for Sustainable Development by Vijay Singh Rathore and B S Rathor, Daya Publishing House.
2. Sustainable Natural Resource Management by Danill R. Lynch.

Agricultural Journalism 3 (2+1)

Objective

To acquaint the qualities and role of journalist /journalism in agricultural development and development of media

Theory

Journalism – Meaning, nature, importance and types of journalism, Agricultural Journalism – Meaning, definition, principle, objectives, types, and scope, Similarities and difference between agricultural journalism and other types of journalism, Role of agricultural journalist, Training of agricultural journalist, Qualities of journalist, Role of journalist /journalism in agricultural development and development of newspaper and magazines readers, Newspaper and magazines as communication media: Characteristics, kinds and functions of newspaper and magazines, Characteristics of newspaper and magazines readers, Form, content, style and language of newspaper and magazines, Standard part of newspaper and magazines, The agricultural story: Types of agriculture stories, subject matter of the agricultural story, structure of the agricultural story, Gathering farm information - Sources of farm information: abstracting from research and scientific materials, interviews, coverage of events, other sources: electronic media, field study. Success stories-definition, nature, components, guidelines of writing a success story, Writing a news story difference between news and feature story, the principle of writing a news story, Inverted pyramid structure, Organizing the material, treatment of the story, writing the news lead and the body Readability measure-readability ease score, automated readability index, gunning fog index, How to improve readability of articles and stories, Use of photograph in agricultural journalism- Basic principles of photography – composition, exposure, lens, light Use of artwork (Graphs, charts maps, etc), Writing the captions, Editorial mechanism: Copy reading, headline and title writing Proof reading: definition, signs and symbols of proofreading, level of proofreading, duties of a proof-reader, Layout– Meaning, principles of layout and design.

Practical

Practice in writing an agricultural news story, Practice in writing an agricultural feature story, Covering agricultural events for the information collection, Practice in interviewing for the information collection, Abstracting stories from research and scientific materials and wire services, Selecting pictures and artwork for the agricultural story, Practice in editing, copy reading, Practice in headline and title writing, Practicing proof reading,, Practice in lay outing of newspaper, Testing copy with a readability formula, Visit a publishing office.

Suggested Readings

1. Agricultural Extension and Farm Journalism, book by A K Singh,
2. Basic Journalism, Book by Rangaswami Parthasarathy
3. Farm Journalism – Jana and Mitra.
4. Farm Journalism and Media Management – Bhaskaran et al,
5. Introduction to Journalism, Book by Carole Fleming, Emma Hemmingway, and Gillian Moore
6. News Reporting and Editing, Book by K. M. Shrivastava
7. Prepared You Tube videos.
8. Professional Journalism, Book by MV Kamath
9. The Journalist's Handbook, Book by MV Kamath.
10. Web Materials

Landscaping 3 (2+1)

Objectives

1. To educate the students on designing different styles and types of gardens
2. To enable the students to identify different ornamental plants and their utilization in landscaping design
3. To enable students to design landscapes in softwares like AUTOCAD, ARCHCADE etc.

Theory

Importance and scope of landscaping, Principles of landscaping, garden styles and types terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes, Trees: Selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture, Climber and creepers importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, Other garden plants: palms, ferns, grasses and cacti succulents, Pot plants: selection, arrangement, management, Bio-aesthetic planning: Definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions, Bonsai principles and management, Lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software, visit to important gardens /parks /institutes.

Suggested Readings

1. Principles of Landscape Gardening by S.Y. Chandrasekhar and B. Hemla Naik.
2. Textbook of Floriculture and Landscaping by Anil K. Singh and Anjana Sisodia.

Commercial Plant Breeding 3 (2+1)

Objectives

1. To discuss about hybrid development and various crop improvement aspects of field crops viz., rice, wheat, maize, pearl millet, sorghum, pigeonpea, chickpea, green-gram, black gram, lentil, soybean, groundnut, rapeseed- mustard, cotton etc.
2. To provide understanding on tissue culture and biotechnological approaches as alternative strategies for development of line and cultivars
3. To impart knowledge on seed production, release and notification of varieties and PPV&FR Act, 2001

Theory

Types of crops and modes of plant reproduction, Line development and maintenance breeding in self- and cross- pollinated crops (A/B/R and two line system) for development of hybrids and seed production, Genetic test of commercial hybrids, Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment, Alternative strategies for the development of the line cultivators: haploid inducer, tissue culture techniques and biotechnological tools, IPR issues in commercial plant breeding: DUS testing and registration of verities under PPV and FRA Act, Variety testing, release and notification systems in India, Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques, Techniques of seed production in self and cross pollinated crops using A/B/R and two line system, Learning techniques in hybrid seed production using male- sterility in field crops, Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production, Concept of rouging in seed production plot, Concept of line its multiplication and purification in hybrid seed production, Role of pollinators in hybrid seed production, Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops, Sampling and analytical procedures for purity testing and detection of spurious seed, Seed drying and storage structure in quality seed management, Screening techniques during seed processing viz. grading and packaging, Visit to public and private seed production and processing plants.

Suggested Readings

1. Breeding Field Crops by JM Poehlman.
2. Commercial Plant Breeding at a Glance by Phundan Singh, Pratibha Bisen, Reshu Tiwari. Daya Publishing House
3. Plant Breeding: Principles and Methods by B. D. Singh. Kalyani Publishers
4. Principles of Plant Breeding (1st and 2nd edn) by RW Allard.

Food Safety and Standards 3 (2+1)

Objectives

1. To develop the skills to convert raw materials into safe, attractive food products
2. To manage the production of food products
3. To use scientific knowledge to develop new products

Theory

Food safety –Definition, Importance, Scope and Factors affecting Food Safety, Hazards and Risks, Type of Hazards - Biological, Chemical Physical hazards, Management of hazards – Need, Control of Parameters, Temperature Control, Food Storage, Production Design, Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control, Waste Disposal, Pest and Rodent Control, Personnel Hygiene, Food safety Measures, Food Safety Management Tool- Basic concepts, PRPs, GHPs, GMPs, SSOPs etc. HACCP.ISO series, TQM- Concept and need for quality, components of TQM, Kaizen, Risk Analysis, Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene, Food laws and Standards Indian Food Regulatory Regime, FSSAI. Global Scenario CAC, Other laws and standards related to food, Recent Concerns-New and Emerging Pathogens, Packaging, Product labelling and nutritional labelling, Genetically modified food/transgenic, Organic foods, Newer approaches to food safety, Recent Outbreaks, Indian and International Standards for food products.

Practical

Water quality analysis: physio–chemical and microbiological, Preparation of different types of media, Microbiological examination of different food samples, Assessment of surface sanitation by swab/rinse method, Assessment of personal hygiene. Biochemical tests for identification of bacteria, Scheme for the detection of food borne pathogens, Preparation of plants for implementation of FSMS- HACCP, ISO: 22000.

Suggested Readings

1. Text book of Food Science and Technology by Avantina Sharma.

Bioformulation and Nano-formulation 3 (2+1)

Objectives

1. To enable students to acquire expertise and skill to develop bioformulation and Nano-formulation
2. To know the importance of biopesticides and biofertilizers
3. To make the students know about various techniques involved in biofertilizers and biopesticides production
4. To get knowledge on essential oils, botanicals, predators, parasitoids, Pheromones, and parapheromone and their application in insect-pest management
5. To get concepts on agrochemical formulations with nanoparticles and acquaint them with nanotechnology

Theory

Introduction and history of biological control of pests and diseases, Microbial biopesticides: the global and Indian market scenario; biopesticides for organic agriculture, Different phytopathogenic biocontrol agents: Mode of action, Different entomopathogenic biocontrol agents: Mode of action, Microbial inoculants as biofertilizer candidates, Production, quality assessment and methods of application of biopesticides and biofertilizers, Regulatory system of biopesticides in India, Formulations of plant essential oils, botanicals, Pheromone, and parapheromone and their application in insect pest management, Use of predators and parasitoids for insect pest management, Nanotechnology: Its applications in pest and disease diagnosis and management, Nano biopesticides: Concept and importance, different techniques of producing nano biopesticides, Nano fertilizers: Concept and importance, Types of nano fertilizers, Different techniques of producing nano fertilizers, Green synthesis of nano fertilizers, green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles

Practical

Introduction and acquaintance with biopesticide laboratory, Preparation of culture media, Isolation and purification of bioagent from soil and infected insects, Microscopic study of different microbial bioagents, *In vitro* assay of microbial bioagents against plant pathogens.

In vitro compatibility study among different microbial bioagents, Mass multiplication of biopesticides, Population enumeration of biocontrol agents in different biopesticides, Preparation of plant extracts and their efficacy test against insect pests, Use of pheromone parapheromone for monitoring and management of insect pests, Bioassay of Entomopathogenic biocontrol agents on insect-pests, Preparation of microbial inoculants of biofertilizer microbes, Compatibility of biofertilizer microbes, Preparation of solid and liquid consortia of biofertilizer microbes.

Suggested Readings

1. Allhoff, Fritz and Lin, Patrick (Eds) 2009. Nanotechnology and Society, ISBN: 978-1-4020-6208-7 Springer Publications, UK.
2. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society.
3. Boland, G.J. and David, L.1998. Plant Microbe Interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology.
5. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
6. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural products.
7. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
8. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services Bengaluru.
9. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services Bengaluru.

Biopesticides and Biofertilizer 3 (2+1)

Objectives

1. To provide knowledge on principles, methods, and mechanisms of bio-control agents and their use against plant diseases
2. To provide knowledge on principles, methods, and mechanism of biofertilizers and their use in agriculture

Theory

History and concept of bio pesticides, Importance, scope and potential of biopesticides, Definitions, concepts and classification of biopesticides viz. Pathogen, botanical pesticides, and bio rationales. Botanicals and their uses. Mass production technology of bio-pesticides, Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes, Methods of application of biopesticides. Methods of quality control and Techniques of bio pesticides. Impediments and limitation in production and use of biopesticides.

Biofertilizers - Introduction, status and scope. Structure and characteristics features of bacterial biofertilizers – *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*; Cynobacterial bio fertilizers- *Anabaena, Nostoc, Hapalosiphon* and fungal biofertilizers – AM mycorrhiza and ectomycorhiza. Nitrogen fixation –Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertizers, FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers: Storage, shelf life, quality control and marketing. Factors influencing the efficiency of biofertilizers.

Practical

Isolation and purification of important biopesticides: *Trichoderma, Pseudomonas, Bacillus, Metarhyzium* etc. and its production, Identification of important botanicals, Visit to biopesticide laboratory in nearby area, Field visit to explore naturally infected cadavers, Identification of entomopathogenic entities in field condition, Quality control of biopesticides, Isolation and purification of *Azospirillum, Azotobactor, Rhizobium,* P-solubilizers and cyanobacteria, Mass multiplication and inoculums production of biofertilizers, Isolation of AM fungi- Wet sieving method and sucrose gradient method, Mass production of AM inoculants**.**

Suggested Readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American Phytopathological Society.
2. Biofertilizers for Sustainable Agriculture- Sampat Nehra, Aavishkar Publishers, Jaipur, India.
3. Boland, G.J. and David, L.1998. Plant microbe interactions and Biological Control. Kuykendall Marel Dekker, INC.
4. Borkar, S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology.
5. Ciancia, A. and Mukerji, K.J. 2007. General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.

6. Cincholkar, S.B. and Mukherji, K.G. 2007. Biological Control of Plant Diseases. Hawarth Food and Agricultural Products.
7. Earthworm Vermiculture and Vermicomposting by R.K. Bhatnagar, R.K. Palta, Kalyani Publishers
8. Fungal Biopesticides and VAM Applications by P.C. Trivedi, Pointer Publishers, Jaipur, India
9. Gnanamanickam, S.S. 2002. Biological Control of Crop Disease. Kuykendall Marel Dekker, INC.
10. Handbook of Microbial Biofertilizers by Dr Awani Kr. Singh, Agrotech Press, Jaipur, India
11. Organic Farming by A.K. Singh, New India Publishing Agency, New Delhi
12. Organic Farming: Standards, Accreditation, Certification and Inspection- Dushyent Gehlot, Agrobios (India)
13. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services Bengaluru.
14. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype Services Bengaluru.

System Simulation and Agro-advisory 3 (2+1)

Objectives

1. To impart the knowledge of statistical and simulation modelling in crop yield estimation
2. To get acquainted with different weather forecasting techniques and their usability analysis
3. To study about the preparation and dissemination of agro-advisory bulletin

Theory

System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts and techniques, types of crop models, data requirements, relational diagrams, Evaluation of crop responses to weather elements; Elementary crop growth models: Calibration, validation, verification and sensitivity analysis, Potential and achievable crop production- concept and modelling, techniques for their estimation, Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance, Weather forecasting, types methods, tools and techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop- Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast, Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.

Practical

Preparation of crop weather calendars, Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts, Working with statistical and simulation models for crop growth, Potential and achievable production; yield forecasting, insect and disease forecasting models, Simulation with limitations of water and nutrient management options, Sensitivity analysis of varying weather and crop management practices, Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast, Feedback from farmers about the agro-advisory.

Suggested Readings

1. Advances in Plant Atmospheric Interactions (Eds. Rao, V.U.M., Rao, A.V.M.S., Rao, G.G.S.N., Ramana Rao, B.V., Vijaya Kumar, P. and Venkateswarlu, B), Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad.
2. Agricultural Meteorology by G.S.L.H.V. Prasado Rao.
3. Introduction to Agrometeorology by H. S. Mavi.
4. Principles of Agricultural Meteorology by OP Bishnoi.
5. Text Book of Agricultural Meteorology. ICAR by MC Varshneya and PB Pillai.

Hi-tech Horticulture 3 (2+1)

Objective

Theory

Introduction and importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods, Protected cultivation: advantages, controlled conditions, method and techniques, Micro irrigation systems and its components; EC, pH based fertilizer scheduling, canopy management, high density orcharding, Components of precision farming : Remote sensing, Geographical Information System (GIS), Differential Geo- Positioning System (DGPS), Variable Rate Applicator (VRA), application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical

Types of polyhouses and shade net houses, Intercultural operations, tools and equipments identification and application, Micro propagation, Nursery- Portrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Suggested Readings

1. Hi-tech Horticulture by T.A. More.
2. Greenhouse Operation and Management by Paul V. Nelson.

Protected Cultivation 3 (2+1)

Objectives

1. To educate the students on different protected structures
2. To educate the students on agro-techniques and management of different horticultural crops under protected environmental conditions

Theory

Protected cultivation: Importance and scope, status of protected cultivation in India and World types of protected structure based on site and climate, Cladding material involved in greenhouse/ poly house, Greenhouse design, environment control, artificial lights, Automation, Soil preparation and management, Substrate management, Types of benches and containers, Irrigation and

fertigation management, Propagation and production of quality planting material of horticultural crops, Greenhouse cultivation of important horticultural crops-rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants etc. Cultivation of economically important medicinal and aromatic plants, Off- season production of flowers and vegetables, Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, use of portrays in quality planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement. Regulation of irrigation and fertilizers through drip, fogging and misting.

Suggested Readings

1. Green House Operation and Management by Paul V. Nelson.
2. Protected Cultivation of Horticultural Crops by Madan Kr. Jha, Sujan Singh Paikra and Manju Rani Sahu.

Climate Resilient Agriculture 3 (2+1)

Objectives

1. To impart the concept of climate resilient agriculture under the present context of climate change
2. To study the integrated role of different sectors in building resilience to climate change in agriculture

Theory

Climate change and impacts of climate change on agriculture and food security; crop productivity under different climate change scenarios including extreme events such as drought, flood, pest and disease outbreak etc. Basics of adaption and mitigation in the agricultural sectors; analyzing and assessing climate vulnerability to identify vulnerable sectors and possible adaptation options in agriculture; assessing biophysical and socio- economic impacts on agricultural sector; risk assessment strategies, preparedness for weather and climate risks in agriculture; application of geospatial tools and techniques for sustainable agriculture.

Climate resilient agriculture (CRA) – Concept, scope and importance with special reference to India, climate resilient technologies for enhancing crop productivity and sustainability, Role of weather and climatic information, agro-advisories, ICTs and simulation models; climate resilient agronomic practices – Crop/cultivar selection, crop diversification/ crop mixtures; Water management practices – Rain water harvesting, micro-irrigation, deficit irrigation and drainage management, organic/natural farming, integrated farming systems (IFS); site specific nutrient management (SSNM), conservation agriculture technologies to build soil organic carbon, harnessing microbial biodiversity, biomass recycling; use of renewable sources of energy; climate resilient pest-disease management strategies.

Breeding strategies for development of climate change resilient crops and varieties, development of biotic and abiotic stress tolerant/resistant cultivars under changed climatic scenarios including extreme weather events.

Practical

Acquaintance with meteorological instruments including AWS, Statistical techniques to study trend of climatic parameters, Analysis of extreme weather events using non- parametric tests, Building climate change scenarios under different futuristic emission of GHGs, Designing strategies to mitigate the effect of climate change using climate resilient crops/cultivars, climate resilient technologies and manipulation of cropping patterns, Acquaintance with ICTs for effective dissemination of local weather information and agro- advisories, Analysing carbon sequestration potential of different agro-ecosystems; Designing climate smart village model considering the availability of resources. Awareness program on climate change and climate resilient agriculture among farming community.

Suggested Readings

1. Climate Resilient Animal Agriculture by GSLHV Prasada Rao (New India Publishing Agency).
2. Climate Resilient Agriculture: Adaptation and Mitigation Strategies by Bhan Manish, New India Publishing Agency.
3. FAO (2013) Climate-Smart Agriculture Source Book.

Biotechnology of Crop Improvement 3 (2+1)

Objectives

1. To acquaint with biotechnological tools of crop improvement
2. To know about direct and indirect methods of gene transfer
3. To introduce about gene editing in plants
4. To provide knowledge about marker assisted breeding and genomic selection

Theory

Impact of biotechnology on crop improvement and the perspective of society: Various biotechnological techniques available for crop improvement – Plant Tissue Culture, Genetic Engineering, Genome editing, Marker Assisted breeding and Genomic Selection, Biosafety regulations and their application in Agricultural Biotechnology, Soma clonal variation and its use in crop improvement: embryo culture, anther/pollen culture, somatic embryogenesis, artificial seeds, techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in the improvement of crop plants, Direct and Indirect methods of gene transfer in plants - Agrobacterium-mediated gene transfer in dicots and monocots, Direct DNA delivery methods (microinjection, particle gun method, electroporation), gene targeting, Gene silencing techniques, introduction to siRNA, siRNA technology, Micro RNA, construction of siRNA vectors, principle and application of gene silencing, creation of transgenic plants, debate over GM crops, introduction to methods of genetic manipulation in different model systems.

Introduction to genome editing: Various tools of genome editing, CRISPR-Cas9 with specific emphasis on Indian regulations, Cloning genomic targets into CRISPR/Cas9 plasmids, electroporation of Cas9 plasmids into cells, purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing, *in vitro* synthesis of single guide RNA (sgRNA), using Cas9/sgRNA complexes to test for activity on DNA substrates, evaluate Cas9 activity by T7E1 assays and DNA sequence analysis, Applications of CRISPR/cas9 technology in crop plants, Marker Assisted Breeding and Genomic

Selection: Introduction to various DNA- based markers and their use in marker-assisted breeding, Foreground Selection, Recombinant Selection and background Selection, Marker-assisted backcross breeding, marker-assisted selection – success stories, Introduction to Genomic Selection.

Practical

Agrobacterium-mediated transformation in tobacco – Preparation of construct, transfer to binary vector, transform *Agrobacterium*, prepare explant, Inoculation and Co-cultivation, antibiotic based selection of putative transformants, validation using PCR; Genome editing- Preparation of CRISPR/Cas construct, direct transfer to plant, analysis of the targets, Planning of a MABB program – Selection of parents, crossing strategies, marker analysis.

Suggested Readings

1. Brown, T. A. (2006). Genomes (3rd edn). New York: Garland Science Pub.
2. Gene Cloning and DNA Analysis, (2010). Retrieved from http:// biolab.szu.edu.cn/ other web/ lzc/genetic%20engineering/courseware/b1.pdf.
3. Green, M. R., and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Old, R. W., Primrose, S. B., and Twyman, R. M. (2001). Principles of Gene Manipulation and Genomics, 7th Edition: Oxford: Blackwell Scientific Publications.
5. Sander JD and Joung JK. (2014). CRISPR-Cas Systems for Editing, Regulating and Targeting Genomes. Nat Biotechnol. 32:347-355.

Geoinformatics and Remote Sensing, Precision Farming 3 (2+1)

Objective

To provide a comprehensive knowledge of remote sensing, precision farming and its benefits in improving crop production and soil health management.

Theory

Introduction and history of remote sensing; sources, principles of remote sensing, propagation of radiations in atmosphere; Interaction with matter, application of remote sensing techniques land use soil surveys, crop stress and yield forecasting, Advantages and disadvantages of remote sensing, Remote sensing institutes in India, Basic concepts about geoinformatics.

Artificial intelligence: History of artificial intelligence, Fundamentals of Big data and machine learning (ML), Use of artificial intelligence in autonomous systems: agricultural robots and drone monitoring systems, driverless tractors, automated sprinklers and self- harvesting machines etc.; Use of AI in crop analysis: monitoring soil quality, promoting organic crops, monitoring weeds, precision agriculture, using drones for crop analysis; Role of AI for sustainability and climate change, yield and demand forecasting, food tech/ wider value chain including impact of blockchain, AI use for in the emerging markets; Technology deployment like sensors, AI and agricultural technologies and How to scale AI for agricultural technologies applications, Responsible AI in agriculture, Data sharing; Expert System: Introduction to expert system, Characteristics and features of expert system, Applications of Expert System, Importance of Expert systems, Rule based system architecture; Software Agents.

Practical

Familiarization with different remote sensing equipments and data products, Interpretation of aerial photographs and satellite data for mapping of land resources, Global positioning system (GPS), Basics of Geographic Information System (GIS), Georeferencing of topo sheets.

Live examples and case study of AI use in Agriculture, Search and Control strategies: Blind search, Breadth - first search, Depth First search, Hill climbing method, Best First search, Branch and Bound search, Programming in Prolog Syntax and meaning of Prolog Programs, Using Data Structures, Controlling Back- tracking, Input and Output, Built-in Predicates, Using Prolog Grammar Rules, Higher level assignments/exercises for implementation using Prolog.

Suggested Readings

1. Data Analytics in Bioinformatics: A Machine Learning Perspective. Editor (s):. Rabinarayan Satpathy, Tanupriya Choudhary, Suneeta Satpathy, Sachi Nandan.
2. Machine Learning Approaches to Bioinformatics by Zheng Rong Yang.
3. Precision Agriculture Technologies for Food Security and Sustainability, By A El- Kader, M Sherine, M El-Basioni, M Basma.
4. Text Book of Remote Sensing and Geographical Information Systems by M. Anji Reddy.

Micro-propagation Technologies 3 (2+1)

Objective

- To educate the students in detail about the sterilization techniques for explants, preparation of stocks and working solution, culturing of explants, regeneration of whole plants from different explants and hardening procedures

Theory

Introduction, History, Advantages and limitations. Types of cultures (seed, embryo, organ, callus, cell), Stages of micro propagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture), Organogenesis (callusy and direct organ formation), Somatic embryogenesis, cell suspension cultures, production of secondary metabolites, Soma clonal variation, Cryopreservation.

Practical

Identification and use of equipment's in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

Suggested Readings

1. Basics of Horticulture by Jitendra Singh.
2. Introduction to Horticulture by N. Kumar.
3. Handbook of Horticulture by K.L. Chadda.

Commercial Seed Production 3 (2+1)

Objective

- To introduce the basic principles of planting material production at commercial scale and seed quality evaluation

Theory

General Principles of Seed Production**:** Raising the seed crop, Introduction, Procurement of a class of Improved seeds, Reporting to Monitoring or certification Agency, Principles and practices of selection of area and agronomic requirement of seed production of field crops, Importance of isolation distance and rouging, Principles of hybrid seed production in field crops, Principles and practices of selection of area and agronomic requirement of seed production of horticultural crops, Concept of apomixis, male sterility and self-incompatibility and its application in hybrid seed production of horticultural crops.

General Principles of Seed Processing: Introduction, Objectives of Seed Processing, Seed Drying, Principles of Drying, Water vapour equilibrium, Methods of drying seeds, Cleaning and grading, Air and screen machines, Dimensional separators, Density separators, Surface texture separators, Colour separators, Spiral separators, Electric separators, Vibrator separators, Separation based on Affinity to liquids, Seed treatment, Temperature treatment, Chemical treatment, Bagging and Labelling

General Principles of Seed Testing: Seed testing - introduction, Procedure of Seed testing, components of seed quality testing genetic, physical, physiological and seed health testing, Seed sampling, Types of seed sampling, Requirements of sampling, Concept of seed viability and vigour; dormancy, types and principles of seed dormancy, Physiological quality of seed, Principles of seed germination, types of germination, biochemical and genetic basis.

Seed Certification: History, concept and objectives of seed certification; seed certification agency/organization and staff requirement Indian Minimum Seed Certification Standards (I.M.S.C.S.) - General and specific crop standards including GM varieties, field and seed standards.

Seed Industry and Seed Marketing : Introduction, Evolution of the seed industry, Development of the vegetable and Flower seed industry, Seed marketing – Concept, definition and purpose, importance and promotion of quality seed, formal and informal seed supply systems, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins; packaging and labeling, Seed Associations, Factors influencing seed marketing, Seed marketing programs, Seed industry organizations, Marketing of public versus private players, Demand and supply of seed; role of seed replacement rate (SRR), seed multiplication ratio (SMR), economics of seed production; determining seed needs, Seed pricing and price policy, seed processing and /packaging, demand forecasting and factors affecting demand for seeds, effect of price and farm income on seed demand.

Biotechnology in Seed Technology: History of plant tissue culture, Laboratory organization, Composition of nutrient medium, Micro-propagation, Axillary bud proliferation approach, Meristem and shoot tip culture, Bud culture, Advantages of Micro-propagation, Problems associated with micro-propagation, Synthetic seed production, Types of synthetic seeds, methods of development of synthetic seeds, Components of nutrient media for synthetic seed development**,** Storage of synthetic seeds, Advantages and limitations of synthetic seed production.

Practical

Planning of seed production, requirements for different classes of seeds in field crops – unit area and rate.

Operation and handling of mechanical drying equipment; effect of drying temperature and duration on seed germination and storability seed processing equipment; seed treating equipment.

Seed production in cross pollinated crops with special reference to land, isolation, Planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in tomato, Hybrid seed production in Maize, detasseling in maize, identification of rogues and pollen shedders, Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc., Visit to seed processing plant and commercial controlled and uncontrolled seed stores, Seed industries and local entrepreneurships visit to nearby areas, Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, detection of seed borne fungi, bacteria and viruses, identification of storage fungi, control of seed borne diseases, seed treatment methods., Maintenance of aseptic conditions and sterilization techniques, Preparation of nutrient stocks for synthetic media, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Selection of explants for callus induction, Preparation of MS medium for micro-propagation and Callus induction, Inoculation of explants for micro-propagation, Inoculation of explants for callus induction and subsequently regeneration of plantlets from matured seeds of field and horticultural crops, Synthetic seed preparation.

Suggested Readings

1. Agarwal RL. 1997. Seed Technology. 2nd edn. Oxford and IBH.
2. Chawla H.S. (2008) Introduction to Plant Biotechnology, second edition, Oxford &IBH publishing Co. Ltd. 113-B Shahpur Jat, New Delhi-110049.
3. Justice OL and Bass LN. 1978. Principles and Practices of Seed Storage. Castle House Publ. Ltd.
4. McDonald MB Jr and Copeland LO. 1997. Seed Production: Principles and Practices. Chapman and Hall.
5. Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani.
6. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
7. Tunwar NS and Singh SN. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

SKILL ENHANCEMENT COURSES

A student admitted into 1st year of B.Sc. Ag. (Hons.) Natural Farming degree program will take 2 skill enhancement courses each of 2 credits in each semester of first year. Likewise, the student continuing his/her study into 2nd year of B.Sc. Ag. (Hons.) Natural Farming will undergo 2 skill enhancement course each of 2 credits in each of the 2 semesters of 2nd year.

The student can select these courses from a basket of skill enhancement courses as indicated below or courses offered by a College. The courses may be offered as module of complementing courses to help the student to achieve skill in a specific area of his interest. A college will select such skill

enhancement courses in which it has strength as well as there is prospect of local employment and entrepreneurship development.

Indicative List of Skill Enhancement Courses

S. No.	Course Title	Credits
1.	Natural Farming for Crops, Vegetables and Orchard	2 (0+2)
2.	Production Technology of Bio-inputs	2 (0+2)
3.	Business Management in Natural Farming	2 (0+2)
4.	Seed Production and Certification under Natural Farming	2 (0+2)
5.	Agro-Eco Tourism in Natural Farming	2 (0+2)
6.	Animal Feed Management under Natural Farming	2 (0+2)
7.	Analytical Techniques and Instrumentation for Soil Health Card	2 (0+2)
8.	Landscape Designing and Gardening	2 (0+2)
9.	Self Sustainable Kitchen Gardening	2 (0+2)
10.	Commercial Bee-Keeping under Natural Farming	2 (0+2)
11.	Commercial Sericulture	2 (0+2)
12.	Beneficial Insect Farming	2 (0+2)
13.	Bio-fertlizer and Biopesticide (microbials) production	2 (0+2)
14.	Production Technology of Biocontrol Agents	2 (0+2)
15.	Mushroom Production Technology	2 (0+2)
16.	Post-harvest Processing Technology	2 (0+2)
17.	Plantation Crop Production and Processing	2 (0+2)
18.	Poultry Production Technology	2 (0+2)
19.	Piggery Production Technology	2 (0+2)
20.	Commercial Horticulture	2 (0+2)
21.	Floriculture and Landscaping	2 (0+2)
22.	Natural Food Processing	2 (0+2)
23.	Agriculture Waste Management	2 (0+2)
24.	Video Production	2 (0+2)
25.	E-marketing for Natural Farm Produce	2 (0+2)
26.	Production and Marketing of Aerated and Non-aerated Liquid Manures	2 (0+2)

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc Ag. (Hons) Natural Farming.

The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by the Institute/ University offering the courses. However, the University/ institute will keep a record of such courses registered and completed by each student and will

indicate the title of the (successfully completed) courses in final transcript issued to the student. The courses can be taken during whole span of degree parogram as per choice of students. The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course). The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

List of Suggestive Online Courses

Course Title	Duration	Credits
Digital Media	16 weeks	1
Basics of Photography	12 weeks	1
Design, Technology and Innovation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Communication and Extension for Sustainable Development	15 weeks	1
Intellectual Property	12 weeks	1
Biopsychology	15 weeks	1
NGO'S and Sustainable Development	15 weeks	1
Counseling Psychology	12 weeks	1
Gender Sensitization: Society Culture and Change	16 weeks	1
Basics of Health Promotion and Education Intervention	8 weeks	1
Psychology of Stress, Health and Well-being	12 weeks	1
Diet Management in Health and Disease	12 weeks	1
Dairy and Food process and products technology	12 weeks	1
Thermal Processing of Foods	12 weeks	1
Nano-technology, Science and Applications	8 weeks	1
Food Science and Processing	12 weeks	1
Diet Management in Health and Disease	8 weeks	1
Human Nutrition and Biochemistry	12 weeks	1
Personality Development and Communication Skills	8 weeks	1
Public Speaking	8 weeks	1
Personality Development	8 weeks	1
Emotional Intelligence	8 weeks	1
Yoga Practices1	12 weeks	1
Yoga Practices2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1
Information Sources and Library Services	6 weeks	1
Qualitative Research Methods and Research Writing	12 weeks	1
Food Science & Processing	12 weeks	1
Food Safety & Quality Control	8 weeks	1
*Communication Skills and Computer Operations	24 weeks	2

Course Title	Duration	Credits
*Human Resource Management	24 weeks	2
*Business Plan and Finance Management	24 weeks	2
$ Physical Education, First Aid and Yoga (to be added)	Compulsory Non-credit Course (CNC)	
$ Start-up (to be developed)		

SAUs will be free to include more Elective courses with approval from their competent bodies.

$ Compulsory Non-Credit (CNC) course for student.

* The list of Non-Credit courses will be uploaded on College/University website. The student will have choice to select courses of his/her choice up to 20 credits.

Annexure-I

List of Members of Sixth Deans' Committee

S. No.	Name	Expert
1.	Dr Tej Partap Former Vice Chancellor, GBPUAT Pantnagar; SKUAST, Srinagar and CSKHPKV, Palampur	Chairman
2.	Dr Jayant Deka Dean, Faculty of Agriculture, AAU Jorhat (Assam)	Member
3	Dr Sanjaya K Dash Dean, College of Agricultural Engineering and Technology, OUAT, Bhubaneshwar (Odisha)	Member
4.	Dr V R Kiresur, Professor (Agric. Economics), Director of Education, UAS, Dharwad 580005 Karnataka	Member
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7.	Dr R R B Singh Vice Chancellor, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh	Member
8.	Dr B.K. Das, Dean, Faculty of Fishery Sciences, WBUAFS, Kolkata, West Bengal	Member
9.	Dr Rita Singh Raghuvansi Former Dean, College of Home Science, GBPAUT, Pantnagar, Uttarakhand	Member
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11.	Dr K.T. Parthiban Dean (Forestry), Forestry College and Research Institute, Tamil Nadu Agric. University, Mettupalayam, Tamil Nadu	Member
12.	Dr M I S Gill Dean, College of Horticulture and Forestry, PAU, Ludhiana, Punjab	Member
13.	Dr S. Chandrasekhar Professor and Head, Department of Sericulture, UAS, GKVK, Bellary road, Bengaluru, Karnataka	Member
14.	Dr Shanti K Sharma Assistant Director General (HRM), Agril education Division, ICAR, KAB-II, New Delhi	Member
15.	Dr Ajit Singh Yadav Assistant Director General (EQAR), Agric. Education division, ICAR, KAB-II, New Delhi	Member-Secretary

Annexure-II

Abbreviations

ICAR	Indian Council of Agricultural Research
ABC	Academic Bank of Credit
ABM	Agribusiness management
AEC	Ability Enhancement Courses
AI	Artificial Intelligence
CAU	Central Agricultural University
CCFU	Curriculum and Credits Framework for Undergraduate
CGPA	Cumulative grade point average
CU	Central University
DDG	Deputy Director General
DG	Director General
DU	Deemed University
ELP	Experiential Learning Program
GER	Gross Enrolment Ratio
HAEI	Higher Agriculture Education Institute
MDC	Multi-disciplinary courses
MOOC	Massive Open Online Courses
NAEAB	National Agricultural Education Accreditation Board
NCC	National cadet Corps
NEP	National Education Policy
NG	Non-gradial
NGO	Non Government Organization
NHEQF	National Higher education Qualification Framework
NSS	National Service Scheme
OGPA	Overall Grade Point Average
PG	Postgraduate
PSSB	Professional Standards Setting Body
RAWE	Rural Agriculture Work Experience
READY	Rural Entrepreneurship Awareness Development Yojna
SAU	State Agricultural University
SEC	Skill Enhancement Courses
UG	Undergraduate
UGC	University Grants Commission
VAC	Value added courses

Annexure-III

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Natural Farming

Heartfelt thanks to the Curriculum Development Committee for their meticulous planning and strategic insight, ensuring that the entire course aligns with our educational objectives and meets the needs of our learners.

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