



Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes (COs)

(2018-19 to 2022-23)



Masters & Doctoral

Programmes

Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110

website: <https://svpuat.edu.in>

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Documentation Summary Sheet

Criterion	Criterion 01–Curricular Aspects	
Key Indicator (KI)	1.1 Curriculum Design and Development	
Metric No	1.1.1: Curricula developed and implemented have relevance to the local, national, regional, and global developmental needs, which is reflected in the Programme outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes (COs) of the Programmes offered by the University	
S.N.	Programme Name (Undergraduate)	Pg. No.
1	BSc (Hons.) Ag	3-26
2	B.Tech (Biotechnology)	27-37
3	BVSc & AH	38-44
4	B. Tech (Food Tech.)	45-47
5	B. Tech (Dairy Tech.)	48-83
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7	BSc (Horticulture)	93-95

COLLEGE OF AGRICULTURE

Undergraduate

Degree Programme: - BSc (Hons.) Ag

The College of Agriculture, as the first constituent faculty of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, was established in year 2000 within the existing infrastructure and manpower as the western campus of GBPUA&T, Pantnagar consequent upon the division of the Uttar Pradesh. The college admitted 23 students in undergraduate degree programme in academic session 2001-02. Since then, the college has been progressively gaining new dimensions in all the spheres.

Objective:

1. To impart teaching for the development of human resource who can apply their acquired knowledge and skills to diversify and industrialize agriculture for socio-economic transformation of the rural society.
2. To develop strategies for enhancing income of farmers and to make them globally competitive.
3. To support extension education programme for upliftment of rural masses

PROGRAMME OUTCOMES (POs)

Students graduating with the B.Sc. (Hons.) Agriculture degree should be able to acquire

- PO-1: Sound knowledge in the agriculture and allied science subjects required to solve local problems in management of crop cultivation, improvement, livestock rearing and their marketing.
- PO-2: Able to recognize and examine the relationships between inputs and outputs in their agricultural field to make effective and profitable decisions. To understand the process of entrepreneurship.
- PO-3: Understand the impact of the professional agricultural solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO-4: Demonstration on research-based knowledge of the legal and ethical environment impacting agriculture organizations and exhibit an understanding and appreciation of the ethical implications of decisions.
- PO-5: Demonstrate an ability to engage in critical thinking by analysing situations and constructing and selecting viable solutions to solve problems. Ability to work effectively with others. To develops analytical ability and team work spirit.



- PO-6: Understand and analyse the current events and issues that are occurring in agriculture and how they affect futuristic agriculture.
- PO-7: Understand how all aspects of agriculture combine and are used by scientists, marketers, producers and understand how employer characteristics and decision-making at various levels enhance the success of an agricultural enterprise. To understand components of agri-business and economics of market.
- PO-8: Able to demonstrate critical thinking and problem-solving skills as they apply to a variety of animal and or plant production systems. To understand problem solving skills in crop production and animal husbandry.
- PO-9: Knowledge of Weather codes and Symbols, Reading and Recording of weather and climatic data. To get trained for climatologically records, soil data and soil nutrition.
- PO-10: To develop critical and self-critical opinion and approach aiming at solving the most important practical problems in the field of agriculture to develop competence to work in Government, public and private sectors
- PO-11: Demonstrate knowledge and understanding in horticulture section: Current applications of horticultural principles and practices: propagation, pest management, production, maintenance, and business practices. Comprehensive knowledge of horticultural production
- PO-12: This programme will also help students to enhance their employability for jobs in different sectors

PROGRAMME SPECIFIC OUTCOME (PSOs)

- PSO-1: Impart knowledge from ancient to modern agricultural practices
- PSO-2: Impart in-depth practical knowledge in crop cultivation practices
- PSO-3: Acquire detailed knowledge about agri-allied sectors
- PSO-4: Deliver knowledge on working of different farm implements
- PSO-5: Able to serve the rural agricultural population
- PSO-6: Diffuse recent agricultural technologies through extension.
- PSO-7: Detailed knowledge on various agri-business activities through student READY program



COLLEGE OF BIOTECHNOLOGY

Undergraduate

Degree Programme: - B. Tech Biotechnology

Objectives

1. The course gives student an opportunity to learn about global trends that influence our Biological systems, environment and the living conditions and learn how different biotechnological approaches are used around the world to manage various relevant issues in diverse areas of biology.
2. The student will develop simulations to think as a biotechnological strategist and design an appropriate solution to diverse problems in areas of Agriculture, Health, Industry etc.
3. Students will develop ethical practices and imbibe values for becoming Biotechnology professionals.

PROGRAMME OUTCOMES (POs)

- PO-1: An Understanding of Biotechnological Functions: Expertise in learning processes and functions that operates in Biological Organisms.
- PO-2: Interpersonal Skill Development: Expertise in communication both spoken as well as written.
- PO-3: Developing Critical and Analytical Thinking Abilities: Critical thinking in academics, presentations, research and professional alliances relies heavily on one's ability to be creative.
- PO-4: Developing Entrepreneurship Acumen: Helps to prepare students for research/managerial roles and as entrepreneurs.
- PO-5: Developing skills to solve real-world biotechnological problems: Equips students to demonstrate the capabilities required to apply cross-functional knowledge and technologies in solving real-world biotechnological problems.
- PO-6: Appropriate techniques: Enables students to demonstrate use of appropriate techniques to effectively manage academic and research challenges.
- PO-7: Practical exposure: Providing an opportunity for the students to gain practical exposure towards the workplace of biotech laboratory and make them industry ready.
- PO-8: Decision Making: Equip students with techniques of analyzing and interpretation of the research data which is used in Decision Making.

PROGRAMME SPECIFIC OUTCOMES (PSOs)



- PSO-1: To develop students with the ability to analyse various functional issues affecting the biotechnological organization and acquiring conceptual clarity of various functional areas of biotechnology.
- PSO-2: The students understand the ethical challenges and choices in a biotechnological unit setting and develop ability to evolve strategies for research/ organizational benefits.
- PSO-3: To inculcate in students the ability to gain multidisciplinary knowledge through seminar reports, case study analysis, Research projects and industrial training and Organizational visits.
- PSO-4: Demonstrate ability to work in Groups and acquire leadership quality required in their career.

COURSE OUTCOMES (COs)

Subject	Subject Code	Course Outcomes
Human Ethics	BAS 112	CO1. Understand and analyses universal human aspirations, Human values and ethics, Sensitization towards others. CO2. Understand and associate spirituality, positive attitude and scientific temper CO3. Understand rights and responsibilities, Human relations and harmony CO4. Provide depth knowledge on developing personal code of conduct (SWOT Analysis) CO5. Management of anger and stress.
Basic Mathematics-I	BAS 116	Learn mathematical description of CO1. Number system and Complex numbers. CO2. Theory of equations. CO3. Geometric, harmonic and binomial series. CO4. Trigonometric calculations.
Basic Botany	BAS 114	Provides study of different aspects of Botany, viz. CO1. Plant kingdom and features of each group. CO2. Cell structure; DNA, chromosome and genes; Cell and tissue types. CO3. Plant taxonomy, systems of classification. CO4. Characteristics and economic importance of different families.
Communication Skills & Personality Development	BAS 115	Development of understanding on CO1. Meaning and process of communication CO2. Reading and comprehension of general and technical articles. CO3. Writing skills, Voice modulation and Oral presentation skills. CO4. Organizing seminars and conferences.

		CO5. Attributes of an effective leader; Stress, conflict and Time management. CO6. Science of body language and role of team work.
Environmental Studies and Disaster Management	AGE/ SAC/ AGR 114	To describe, explain, and integrate fundamental concepts underlying CO1. Natural resources and its conservation for sustainable lifestyles. CO2. Ecosystems, Biodiversity and its conservation; CO3. Environmental issues like water, forest, land, wildlife conservation, Pollution, climate change etc., their effects, control measures and acts. CO4. Disaster management - Efforts to migrate natural disaster at national and global levels.
Food Science and Processing	AGE 113	Students get acquainted with skill in various areas of Food Science and Processing, CO1. Understanding of food and nutrition, CO2. Causes of food spoilage, principles of processing and preservation of food, CO3. Post-harvest handling and technology.
Crop Production Technology	AGR 113	To enable the students to understand about the various areas of crop production technology, CO1. Understanding about Soil and its components, CO2. Agronomy and its relation with other sciences, CO3. Maintenance of Soil fertility and productivity.
Basic Genetics	BTM 111	To help the students focus on and analyze the issues and strategies of basic genetics, CO1. History of Genetics, Mendel principles and genetic basis of evolution. CO2. Multiple allelism, Linkage and crossing-over, CO3. Genetic analysis in prokaryotes and eukaryotes, CO4. Mutations, Hardy-Weinberg law and Quantitative inheritance.
Introduction to Biotechnology	BTO 111	To describe and introduce basic concepts of Biotechnology including, History, definitions, concepts, scope and importance of Biotechnology. CO1. Understand Biotechnological applications in Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural, food and Nano biotechnology.
Cell Biology	BTC 111	Explain the concept of the various constituents of cell biology viz. CO1. Origin and evolution of cell, microscopy; CO2. Sub-cellular structure of prokaryotic and eukaryotic cells; CO3. Membrane structure and function, cell wall and extracellular matrix, CO4. Structure and function of cytoskeleton, CO5. Cell membrane transport, cell signaling, cell cycle and its control.

NCC/NSS/PEY (NG)	NCC/NSS/ PEY- 111	Evoking social consciousness among students through various activities viz., CO1. Working together, constructive and creative social work, CO2. To be skillful in executing democratic leadership, CO3. Developing skill in program development to be able for self-employment, CO4. Increasing physical fitness, awareness and desire to help sections of society.
Basic Zoology	BAS 121	Students will get to know about the introduction to various aspects of Zoology, CO1. Binomial Nomenclature and Classification and general survey of animal kingdom, CO2. Functional organization of various systems of a mammal, CO3. Study of animal cell structure and cell division.
Basic Mathematics- II	BAS 122	Learn mathematical description of CO1. Functions, Limit and Continuity of algebraic, trigonometric and exponential functions. CO2. Differential and Integral Calculus. CO3. Mathematical operations of Matrices and Determinants.
Basic Statistics	BAS 123	To apply various concepts of statistics in analysis of research data in different areas of biotechnology viz. CO1. Definition of statistics, its use and limitations; CO2. Frequency distribution and frequency curve. CO3. Tests of significance CO4. Correlation, regression and analysis of variance.
Production Technologies for Horticultural Crops	HOR 121	To introduce students about CO1. Importance and scope of fruit cultivation; Classification of fruit crops; Climatic requirement, CO2. Importance of vegetable cultivation for nutritional security; Production technology of important vegetable crops, CO3. Status and scope of floriculture in India and abroad; Production technology of commercial flower crops.
Anatomy and Physiology of Livestock	VAN/VPB 123	CO1.To understand the core issues and terms used in veterinary anatomy, CO2. Development and physiology of the organs of digestive, urogenital, cardiovascular, nervous and endocrine glands, CO3. Blood physiology; Genetic and endocrine control of reproductive system.
Basics of Plant Breeding	GPB 122	Awareness about aims and objectives of Plant breeding, CO1. Floral biology of field crops CO2. Methods of breeding for self-pollinated, cross pollinated and vegetatively propagated crops. CO3. Hybridization and its significance in crop improvement.
Introduction to Animal Breeding	AAP 121	To introduce students with newly emerging area of Animal Breeding, CO1. Mating Systems: Inbreeding, Out Breeding and Random mating, CO2. Breeding strategies in different animals.

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Plant Tissue Culture	BTO 121	Familiarizes the students with Concept of aseptic culture and various techniques of plant tissue culture viz. CO1. Somatic cell cultures; CO2. Morphogenesis: organogenesis and somatic embryogenesis; CO3. Micro propagation, Protoplast culture and somatic hybridization.
Molecular Biology	BTM 121	Develops understanding of the students on the biology at molecular level. CO1. Gene structure and function; CO2. DNA replication; transcription; Genetic code and translation, CO3. Gene regulation, CO4. Tools and Role of enzymes in molecular biology.
Biodiversity and its conservation	BTC 121	Introduces students with Concepts of biodiversity, bio resource and wildlife conservation and management strategies. CO1. Sustainable development, Diversification of cropping system, ecosystems and Germplasm banks. CO2. Environmental impact assessment.
Microbiology	BTP 121	Ability to understand practical and theoretical implementation of Microbiology-its applied areas, viz. CO1. Microbial features, growth and metabolism. CO2. Microorganisms and their role in fermentation, Soil and environment. CO3. Beneficial microorganisms in agriculture and Plant microbe interaction, CO4. Microbes in composting and biodegradation.
Biomathematics	BAS 211	To introduce the student to the field of biomathematics, CO1. Ordinary differential equation of first order, linear differential equation of higher order and their applications to biological problems, CO2. Numerical methods, definite integrals and its applications.
Information and Communication Technology	BAS 214	Developing understanding about IT tools, IT-enabled services and their impact on society, CO1. Features of machine language, assembly language, high-level language and their advantages and disadvantages; CO2. Principles of programming, CO3. Introduction to WINDOWS and LINUX Operating Systems, CO4. Introduction to MS Office and its applications.
Economics and Marketing	AAE 212	Students acquires knowledge of CO1. Economics, the kind of markets, cost theory, various issues of demand and other major economic concepts CO2. Have developed skills in role and functions of marketing CO3. Basic guidelines for preparation of project reports for

		various biotechnology/ agricultural products and value added products
Fundamentals of Crop Protection	ENT/ PPA 212	Familiarization of students with Fundamentals of Crop Protection viz. CO1. Importance of insects in agriculture, CO2. Principles and methods of insect-pests management, CO3. Importance and scope of plant pathology, CO4. Nature and classification of plant disease, the Management of key diseases and nematodes of major crops.
Livestock Product Technology	LPT 211	Understanding the basics of Livestock Product Technology, CO1. Composition and nutritive value of milk and meat and various factors affecting their quality, CO2. Milk and meat processing techniques and guidelines.
Breeding of Field Crops	GPB 212	The students will be able to define and explain application of genetic, cytogenetic and biotechnological techniques in breeding of various field crops, CO1. Classes of seed along with its production, maintenance and certification.
Animal Health Care	VMD/VMC 212	Introduction to various aspects of animal health; CO1. Introduction to important diseases of domestic animals, CO2. History of disease diagnosis and medicine; CO3. Animal vaccinations and disease management.
Livestock Production and Management	LPM 212	CO1. Introduction to Livestock Production and Management concepts, CO2. Animal husbandry and Breeds of livestock, CO3. General management and feeding practices of animals, CO4. Common farm management practices CO5. Diseases, parasite & hygiene control.
Recombinant DNA Technology	BTR 211	Understanding the basics of Recombinant DNA technology; CO1. Structure and function of nucleic acids, CO2. Introduction to enzymes used in the technology, CO3. Cloning through PCR and Host-vector system, CO4. Methods of Transformation.
Plant Physiology	BTB 211	Student will be able to understand and correlate concepts of Plant physiology and its scope in agriculture, viz. CO1. Water absorption, water translocation and transpiration; CO2. Stomata mechanisms and photosynthesis, CO3. Dynamics of growth and Stress physiology, CO4. Plant growth regulators, seed germination & seed dormancy.
Biophysics	BAS 221	Provides an insight into application of Biophysics in biotechnology, for e.g. CO1. Quantum mechanics, Electronic Structure of atoms and law of thermodynamics, CO2. Application of various instrumentation techniques used in biotechnology research
Entrepreneurship Development and Business Management	AEC/ AAE 222	CO1. Basic understanding and awareness of different opportunities and successful growth stories. CO2. Learn how to start an enterprise and design business plans those are suitable for funding by considering all dimensions of business.

		CO3. Understand entrepreneurial process and assessment of entrepreneurship skills; SWOT analysis and achievement motivation, CO4. Opportunities and challenges to Indian agribusiness, Management, Project planning, formulation and report preparation.
Electronics and Instrumentation in Biotechnology	BTB/ AGE 221	Use of various facets of Electronics and instrumentation in biotechnology, eg. CO1. Use of PN junction diode, temperature measurement using thermometer and thermocouple, Force measurement using the strain gauge. CO2. Concept of generalized instrumentation system, principles and working of laboratory equipment's.
General Biochemistry	BTB 222	Understanding the basics of Cell structure and biochemical functions e.g. CO1. Bio molecules- primary, Secondary metabolites and their applications in food and pharmaceutical industries. CO2. Bioenergetics and basic Metabolism.
Introductory Bioinformatics	BTI/ BTR 221	To develop a basic understanding of bioinformatics processes viz. CO1. Databases: Nucleotide, protein sequence and Secondary databases, CO2. Introduction to sequence alignment and its applications.
Plant Genetic Transformation	BTM 221	Students will be able to define Application of genetic transformation: for quality, yield, biotic, and abiotic stresses, CO1. Generation of gene construct and Genetic transformation, CO2. Selection and characterization of transgenic plants using selectable and reportable markers and Biosafety aspects.
Classical and Molecular Cytogenetics	BTC 221	Developing an understanding of application of Cytogenetics in Locating genes on chromosome and Genome analysis, CO1. Cell division, CO2. Study of Structure of chromatin and Chromosome by differential staining, CO3. Changes in chromosome number and their structural aberrations.
Microbial Genetics	BTP 221	Students will be able to understand the characteristics, components and concept of Microorganisms as tools for genetic studies using CO1. Recombination and chromosomal mapping; CO2. Complementation testing, CO3. Genetic analysis of representative groups of bacteria, fungi and viruses.
Agricultural Informatics	BAS 311	Student will be Introduced to computers along with,

		CO1. Uses of DBMS in Agriculture Computer programming, CO2. Computer models in agriculture e.g. statistical, weather analysis and crop simulation models. CO3. Application of innovative ways to use information and communication technologies (IT) in agriculture and Decision support systems.
Animal Biotechnology	VMC 312	To introduce students with Basic techniques in animal cell culture and Embryo transfer technology, viz. CO1. Marker assisted breeding of livestock and Introduction to animal genomics, CO2. Rumen, its environment and manipulation of its microbes, CO3. Manipulation of lactation by biotechnological tools; CO4. Application of biotechnology in meat and meat products. CO5. Genome and protein based diagnostics of important animal diseases.
Immunology	BTI 311	CO1. Provides an insight into application of components of immune system, viz, CO2. Immunoglobulin structure functions and Molecular organization, CO3. Allergies, hypersensitive response, Immunodeficiency and Vaccines, CO4. Various Immunological techniques and Molecular diagnostics.
Molecular Genetics	BTM 311	Develops understanding on genetics at molecular level, e.g. CO1. Molecular mechanisms of DNA replication, repair, mutation, and recombination; CO2. Centromere and telomere sequences and DNA packaging; CO3. Synthesis and processing of RNA and proteins; CO4. Regulation of gene expression; CO5. Mutations and DNA repair. CO6. Promoters and Transcription factors and their role in gene expression; CO7. Epigenetic control of gene expression, Small RNAs and RNA interference.
Nanobiotechnology	BTM 312	To explain the core issues of nanobiotechnology, viz. CO1. Biological based Nanosystems, molecular motors,

		<p>biosensors and other devices, CO2. Nanomanipulations, material design, synthesis and their applications.</p>
Molecular Marker Technology	BTF 311	<p>Understanding types and application of molecular markers for CO1. Assessing genetic diversity, variety protection; CO2. Marker-assisted breeding, CO3. Human and animal health, Association with genetic-based diseases, CO4. Paternity determinations and Forensic studies.</p>
IPR, Biosafety and Bioethics	BTF 312	<p>Introduction to types of Intellectual Property and various issues related to it for e.g. CO1. International and Indian Legislations for the protection of various types of Intellectual Property; CO2. Patent search and filing process; CO3. Material transfer agreements.</p>
Genomics and Proteomics	BTR 311	<p>Introduce students with newly emerging area of genomics viz. CO1. Structural genomics, Physical mapping of genomes; Next generation sequencing; Genome analysis and gene annotation; CO2. Genome Projects of various model organisms, CO3. Functional genomics including various Transcriptomics and Proteomics techniques.</p>
Enzymology & Enzyme Technologies	BTB 311	<p>Familiarizes the students with Concept and applications of enzymes in biotechnology, industry, environment, agriculture, food and medicine. It impart exposure in several areas viz. CO1. Classification and nomenclature of enzymes; CO2. General characteristics of enzymes, active site, cofactors, prosthetic groups; CO3. Isolation, purification, characterization and assays of enzyme, CO4. Enzyme kinetics, Regulation of enzyme activity and Enzyme inhibition.</p>
Biostatistics	BAS 321	<p>Enhances the understanding on various applications of statistics in biology, CO1. Random variables and probability distribution of random variables. CO2. Hardy-Weinberg Law and Introduction to Poisson process and Markov chains.</p>


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		<p>CO3. Chi-square test: testing heterogeneity, use in genetic experiment, detection of linkage, linkage ratios and its estimation.</p> <p>CO4. Analysis of variance and Estimation and significance of genotypic and phenotypic variation.</p> <p>CO5. Analysis of covariance, block designs and Testing of heritability.</p>
Computational Biology	BTI/BTR 321	<p>Provides an introduction to computational biology along with Web based servers and software for</p> <p>CO1. Genome visualization and analysis,</p> <p>CO2. Protein interaction databases, Principles of Protein structure prediction, Fold Recognition (threading), Homology modeling and Methods for comparison of 3D structures of proteins.</p> <p>CO3. Phylogenetic analysis and application of Genome browsers in genomic research.</p>
Optional/ Elective Course in Plant Biotechnology	Elective I	<p>Imparting skill set in various areas of Plant Biotechnology viz.</p> <p>CO1. Plant Tissue Culture and its Applications.</p> <p>CO2. Principles and Applications of Plant Genetic Transformation.</p> <p>CO3. Epigenetics and Gene Regulation.</p> <p>CO4. Applications of Genomics and Proteomics.</p> <p>CO5. Molecular Breeding in Field Crops.</p> <p>CO6. Molecular Breeding of Horticultural Crops and Forest Trees</p>
Optional/ Elective Course in Animal Biotechnology	Elective II	<p>Gain attributes and skill set in various areas of Animal Biotechnology viz.</p> <p>CO1. Animal Genomics.</p> <p>CO2. Embryo Transfer Technologies.</p> <p>CO3. Principles and Procedures of Animal Cell Culture.</p> <p>CO4. Transgenic Animal Production.</p> <p>CO5. Molecular Diagnostics.</p> <p>CO6. Molecular Virology and Vaccine Production</p>
Optional/ Elective Course in Microbial and Environmental Biotechnology	Elective III	<p>Provides knowledge and skill set in various areas of Microbial and Environmental Biotechnology viz.</p> <p>CO1. Microbial Biotechnology,</p> <p>CO2. Green Biotechnology.</p> <p>CO3. Molecular Ecology and Evolution.</p> <p>CO4. Molecular Pharming and Biopharmaceuticals.</p>



		CO5. Food Biotechnology. CO6. Bio-prospecting of Molecules and Genes
Optional/ Elective Course in Bioinformatics	Elective IV	Exposure and developing skills in various areas of Bioinformatics viz. CO1. Programming for Bioinformatics. CO2. Computational Methods for Data Analysis. CO3. Bioinformatics Tools and Biological Databases. CO4. Structural Bioinformatics. CO5. Pharmaco genomics. CO6. Metabolomics and System Biology
Educational Tour (NG)	BTS 411	To practically Impart awareness about Local, neighboring or other University/SAU/Research Station/ KVK/ ICAR/ Institutes/ Industries etc. visit based on their importance and relevance for improvement of student exposure towards different Academic/ Industrial environments.
Student READY – (04 Optional topics) In-house Skill Development Modules	BTS 412	The students will be able to know the scope, significance, and methodology used in specialized field of any one chosen elective, Elective I. Plant Biotechnology, Elective II. Animal Biotechnology, Elective III. Microbial and Environmental Biotechnology, Elective IV. Bioinformatics.
Bioprocess Engineering, Bioseparation and Downstream processing	BTO/AGE 411	Student will become efficient and acquire acumen on various aspects of CO1. Bioprocess principles including upstream and downstream processing. CO2. Chemical engineering principles applied to biological system, CO3. Principle of reactor design along with various types of microbial and enzyme reactors and Instrumentation control and optimization, CO4. Mass and Heat transfer. CO5. Media formulation and optimization.
Student READY - Project Formulation, Execution and Presentation	BTS 421	CO1. Carry out a substantial research-based project. CO2. Analyze data and synthesize research findings. CO3. Report research findings in written and verbal forms.
Student READY - Entrepreneurial Development in Biotechnology	BTS 422	CO1. Develop idea generation, creative and innovative skills. CO2. Aware of different opportunities and successful growth stories. CO3. Learn how to start an enterprise and design research



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		plans those are suitable for funding by considering all dimensions of business. CO4. Understand entrepreneurial process by way of studying different case studies.
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COLLEGE OF VETERINARY & ANIMAL SCIENCES

Undergraduate

Degree Programme: - BVSc & AH

Introduction

The livestock sector confers an immense contribution to the rural livelihood and food security of the masses. It provides employment to millions of livestock farmers while acting as a supplementary source of income to many agricultural farmers. It is also disproportionately benefits women being the primary animal husbandry activists in rural areas, and therefore, this sector serves a great contribution to economic and social wellbeing of farmers. Further, the sector provides valuable nutritional sources to the growing children and working population in the form of milk, meat and eggs. College of Veterinary and Animal Sciences (COVAS) was established as a constituent college of the University in 2008, to scale up rural economy by ensuring proper animal health care and management through competent human resource generation. The College has made extensive contribution for the development of animal husbandry sector of the state. In addition to development of human resources for serving the livestock farmers of the state, the college is also instrumental in various research, extension, consultancy and clinical services to the farmers. The Veterinary Council of India (VCI) permitted the admission of first batch of BVSc & AH degree programme in academic session 2011. The college is imparting quality veterinary education, training and development of entrepreneurship skills of the students for employment of the livestock sector. The college of Veterinary and Animal Science offers the Undergraduate (BVSc & AH) degree programmes which is 5½ years duration. The College is under First Schedule of Indian Veterinary Council Act, 1984. As per VCI-2016 there are 17 constituents' departments operating in the college.

Mandate

1. Advancement of education in Veterinary & Animal Science subjects for development of human resources who can apply their acquired knowledge and skills to diversify and industrialize Veterinary Sciences and other Allied sectors for socio-economic transformation of the rural society of Uttar Pradesh in particular and country in general.
2. Conduct basic, strategic and applied research in Veterinary & Animal Sciences.
3. Undertaking field and extension programmes.

Vision

To be a leading and vibrant centre of excellence in teaching, research, innovation and extension in the field of Veterinary and Animal Sciences.

PROGRAMME OUTCOMES (POS):



PO-1: The students will develop the ability in a field of Veterinary medical science about the treatment of animal diseases and ailments.

PO-2: The under graduate students will possess the ability to utilize the knowledge regarding the aspects of animal husbandry, covering the various disciplines of Veterinary Science.

PO-3: The students learn about the application of medical, diagnostic, and therapeutic principles to various types of animals.

PO-4: The student's deals with curing, treating as well as studying the various diseases occurring in animals and birds, thus studying the physiology of the animals in detail.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO-1: To develop knowledge based efficient veterinary resources, enhance animal productivity, improving vaccine development and food processing and to reduce antimicrobial inputs.

PSO-2: To accomplish lab to land concept by disseminating the package of practices of technologies developed at the faculty for farmers to enhance the productivity and quality of human life.

COURSE OUTCOMES (COs):

Subject	Course Outcomes
Veterinary Anatomy	CO1. To define veterinary anatomy and is knowledgeable with regards to main concepts of anatomy. CO2. To provide a general knowledge about the muscles in the animal body. CO3. To provide a general knowledge about the digestive system, respiratory system, circulatory system, nervous system, urinary and reproductive system in the animal body. CO4. To define the osteology of the ox and differences in horse, dog, pig and fowl.
Veterinary Physiology	CO1. The students develop critical thinking skills, to apply physiological concepts and principles at the basic and applied levels, to develop a working knowledge of the major physiological systems. CO2. Student will understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems. CO3. Student should understand how blood circulates and how gases are exchanged. CO4. Understand important physiological challenges animals face and the processes by which animals deal with them. CO5. To define the role of evolutionary processes (e.g. natural selection) in driving the organization of physiological systems.
Veterinary Biochemistry	CO1. The students will learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system. CO2. The students will learn about structure and function of lipids, circulating lipids and inflammatory lipid mediators etc. They will also learn about primary, secondary, tertiary, quaternary structure of proteins. CO3. The students will understand about the structure and function of nucleosides and nucleotides. CO4. The students acquire knowledge in the quantitative and qualitative estimation of biomolecules. CO5. The students in understanding other accessory molecules like



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	vitamins, plant and animal hormones, plant secondary metabolite like terpenes.
Livestock Production Management	<p>CO1. The course provides specialized training in Livestock Production to the extent of the highest expertise to the students.</p> <p>CO2. To build students skills in specialized animal care.</p> <p>CO3. To define animal welfare, sustainable management of feeds, environmental physiology and genetic resources.</p> <p>CO4. To describe the Handling & Restraining, Identification, Judging, Milking, Feeding, Reproduction, Shelter, Labour Management, Management of calf, heifer, milch animals and other categories.</p> <p>CO5. To describe the management of poultry, cattle, goat, sheep, swine, horse species.</p>
Veterinary Microbiology	<p>CO1. Provide basic knowledge and principles of microbiology, the study of microbes, and how microbes are classified.</p> <p>CO2. To define the understanding of transmission strategies, immune evasion and host responses contribute to microbial pathogenesis.</p> <p>CO3. To define acquire knowledge about pathogenesis and epidemiology microbes and the function of the immune system.</p> <p>CO4. To describe the mechanisms by which microorganisms cause disease and the chemotherapeutic methods used to combat these mechanisms.</p> <p>CO5. The students acquire knowledge to take required measurements for prevention and control of bacterial, viral and fungal diseases.</p> <p>CO6. Laboratory sessions emphasize the proper selection, collection and transportation of bacteriologic and fungal specimens.</p>
Veterinary Pathology	<p>CO1. To understand and learn the pathological changes that occur in tissues and organ systems and how such changes provide the basis for clinically-manifested diseases.</p> <p>CO2. To describe and explain changes in organism during typical pathologic processes (for example inflammation, fever, local disturbances of blood circulation).</p> <p>CO3. To explain how animals' normal functions, change and how healing processes work during diseases.</p> <p>CO4. To understands and can describe interactions between disease process and defense, as well as the regulatory mechanism of animals.</p> <p>CO5. To connect the results of clinical and laboratory evaluation of diseased animals to the underlining pathological mechanisms.</p> <p>CO6. The student's exposure to fresh and fixed pathological specimens (from necropsies and abattoir specimens).</p> <p>CO7. To be able to explain the principles and importance of post-mortem examination in disease diagnosis.</p>
Animal Genetics and Breeding	<p>CO1. To describe the science of animal genetics and the practice of animal breeding.</p> <p>CO2. Students will learn about the origin, evolution, and reproduction of animals.</p>

	<p>CO3. Focuses on the development of genomic tools and techniques for understanding the traits of different animals.</p> <p>CO4. Students will be able to carry out research on genome analysis and their findings will be useful for the development of new breeding techniques.</p>
Animal Nutrition	<p>CO1. To describe with the knowledge on feed composition, their digestion processes, and nutrient metabolism.</p> <p>CO2. To describe to evaluate the nutritional value of the different feed components, through the application of various systems.</p> <p>CO3. To provide the student with the necessary knowledge and techniques to evaluate the animal's nutrient requirements in the different growth and production stages and to estimate, control and predict feed intake.</p> <p>CO4. To define how to estimate nutrient requirements and their balance in the different stages of growing and production.</p> <p>CO5. Understand the role of food in meeting the needs of animals, and in preventing metabolic or health problems.</p>
Veterinary Pharmacology and Toxicology	<p>CO1. To describe with an understanding and knowledge of pharmacology, toxicology and therapeutic.</p> <p>CO2. To define the mechanisms of various drug actions, the PD/PK principles that are fundamental for the therapeutic uses and safe selection of therapeutic agents in clinical veterinary practice.</p> <p>CO3. To describe appropriate drug selection for various animal species.</p> <p>CO4. To define the mechanism of therapeutic action of a selected drug at the molecular, cellular, organ system and whole-body levels.</p> <p>CO5. To describe an understanding of the processes involved in absorption, distribution, metabolism and excretion of toxicants, including an understanding of the toxicokinetic behavior of toxicants in animals.</p>
Veterinary Public Health and Epidemiology	<p>CO1. To describe the role of the veterinary profession in the protection of public health.</p> <p>CO2. To explain the important epidemiological features of zoonotic diseases and relate these to control strategies.</p> <p>CO3. To describe the key principles involved in the food chain and the "Farm to Fork" approach and identify critical stages at which risks to public health may occur.</p> <p>CO4. To explain the various aspects of veterinary public health including non-foodborne zoonoses.</p>
Veterinary Parasitology	<p>CO1. To enlighten the students on the need to study veterinary parasitology, their importance in the field of medicine and veterinary sciences, the relationship between various organisms and the types of parasitism.</p> <p>CO2. To describe the knowledge of the terminology, basic principles and application of veterinary parasitology and treatment methodologies</p> <p>CO3. To define theoretical and practical skills required in veterinary parasitology, including the diagnosis, control and treatment of common parasite diseases, including zoonoses.</p> <p>CO4. To includes aspects of life cycles, pathogenesis, diagnosis,</p>

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		epidemiology, treatment and prevention.
Livestock Technology	Products	CO1. To impart knowledge about history, current status of meat industry, muscle composition, functions and sensory quality of meat. CO2. To educate on factors influencing quality of meat and nutritive value. CO3. To motivate farmers, entrepreneurs and unemployed youth to establish their own milk and meat-based enterprises. CO4. The students will do research activities on various aspects like product development, development of functional meat, extension of shelf life, development of milk products etc.
Veterinary Education	and Animal Husbandry Extension	CO1. The students can perceive the importance of extension education in respect to technology transfer among the famers. CO2. They can prepare different audio-visual aids to provide informal education among the farmers. CO3. The students came to know the different strategies to disseminate and diffuse demand driven technologies among the farmers' and provide location specific solutions to solve farmers problem.
Veterinary Practices	Clinical	CO1. To understanding the working of Veterinary Clinics including hospital set up, administration and work force management. CO2. To describe the handling, examination, diagnosis and treatment of sick animals in the field conditions under the supervision of faculty. CO3. Understanding the different methods of record keeping, retrieval, processing, analysis and interpretation of data. CO4. Handling and management of cases of Gynaecology and Obstetrics. CO5. To define and make understanding the use of equipment's used in treatment and Management of various surgical conditions. CO6. Learning the use of various advance non-invasive diagnostic aids like Ultrasonography, Ophthalmoscope
Livestock Farm Practices		CO1. To describe all aspects of animal rearing so that students can rear animals on their own. CO2. Hands on training of the students on the overall farm practices of livestock management including cleaning, feeding, watering, grooming, milking, routine health care, record keeping, sanitation, housing, fodder production, preparation of mineral mixture, cost economic of fodder production. CO3. Care of pregnant animals, management of parturition, care of neonatal and young stock.
Veterinary Radiology	Surgery and	CO1. To describe History taking, physical examination, clinico-pathological testing, intraoperative and postoperative care. CO2. Development of anesthesiology, Terminology, classification and indications. CO3. To understand the different radiology techniques. CO4. To define and make understanding the use of equipments used in treatment and Management of various surgical conditions. CO5. Learning the use of various advance noninvasive diagnostic aids like Ultrasonography, Ophthalmoscope

Veterinary Medicine	<p>CO1. Knowledge and understanding about basic and applied medicine science.</p> <p>CO2. Know the aetiology, pathogenesis, clinical signs, diagnosis and treatment & prevention of the common diseases and disorders that occurs in all domestic animals.</p> <p>CO3. To know main medicines, their effect, pharmacodynamics, pharmacokinetics and responsible use of medicines.</p> <p>CO4. To understand and apply in practice principles of evidence-based veterinary medicine.</p>
Veterinary Gynecology and Obstetrics	<p>CO1. To develop students with basic knowledge and skill of gynecology</p> <p>CO2. To describe the causes of infertility in bovines.</p> <p>CO3. To describe scientific knowledge on physiological reproductive processes of reproductive system of animals.</p> <p>CO4. To define how to conduct investigations on the problems pertaining to animal reproduction.</p>



COLLEGE OF POST HARVEST TECHNOLOGY & FOOD PROCESSING

Undergraduate

Degree Programme: - B. Tech (Food Technology)

PROGRAMME OUTCOMES (POS)

To establish itself as the leader in human resource development for supporting the food technology sector.

To provide knowledge and skill for better preservation techniques, processing and value addition to agricultural products.

To provide well equipped infrastructure and research facilities to students for carrying smoothly in allied fields of food sector.

To develop an awareness among the students about environmental issues and towards sustainable developments.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

To impart knowledge in various aspects of food technology through theory and practical knowledge.

To make the students familiar with the technologies of food processing and preservation of plant and animal foods, cereals, fruits, vegetables etc.

To gain knowledge about advanced technologies adapted in various food industries by physically visiting different food industries.

Give students assistance in preparing for competitive exam.

COURSE OUTCOMES (COS)

Subject	Sub Code	Course Outcomes
English Language	FBS 111	To understand the chemistry of foods-composition of food, role of each component and their interaction.
General Microbiology	FSQ 111	
Engineering Mathematics-I	FBS 112	
Engineering Drawing and Graphics	FBE 111	To understand the functional aspects of food components and to study their role in food and nutrition.
Basic Electrical Engineering	FBE 112	To understand the general chemical structures of the major components of foods (water, proteins, carbohydrates, and lipids).
Workshop Technology	FBE 113	
Crop Production Technology	FBS 113	
Environmental Sciences & Disaster Management	FBS 114	To understand the pigments and flavours and their role of food industries.
Physical Education	PPE 111	To understand the role of anti-oxidants, allergens, toxins and anti-nutritional factors in foods.
Food Chemistry of Macronutrients	FSQ 121	
Food Microbiology	FSQ 122	To understand sources and functions of different nutrients, diseases related to their deficiencies, their transport, digestion and metabolism.
Food Thermodynamics	FPE 121	
Computer Programming and Data Structures	FBE 122	To understand the principle of Unit operation.
Fluid Mechanics	FPE 122	
Basic Electronics Engineering	FBE 123	To acquaint with fundamentals of food engineering and its process.
Engineering Mathematics-II	FBS 121	

Post Harvest Engineering	FPE 123	To understand the basics of designing of food plant and systems.
NCC/NSS	NCC 124 / NSS 124	To understand basics of designing of food plant and storage system.
Fundamentals of Food Processing	FPT 211	To know the important genera of microorganisms associated with food and their characteristics.
Processing Technology of Liquid Milk	FPT 212	To understand the role of microbes in fermentation, spoilage and food borne diseases
Processing Technology of Cereals	FPT 213	To understand the important genera of microorganisms associated with food and their
Industrial Microbiology	FSQ 211	To comprehend the role of the microorganisms in spoilage of foods and methods of their control.
Food Chemistry of Micronutrients	FSQ 212	To gain knowledge about the beneficial role of microorganisms and different types of fermented foods.
Heat and Mass Transfer in Food Processing	FPE 211	To identify the role of microorganisms in food borne diseases and control measures
Unit Operations in Food Processing-I	FPE 212	To understand the laboratory techniques to detect, quantify, and identify microorganisms in foods.
Statistical Methods and Numerical Analysis	FBS 211	To develop knowledge and skills for estimation of important compositions of food such as protein, carbohydrates, fats etc.
Processing Technology of Dairy Products	FPT 221	To develop knowledge and skills for estimation of essential components such as moisture, acidity, ash etc.
Processing Technology of Legumes and Oilseeds	FPT 222	To develop skills for determination of viscosity of various fluids
Food Biochemistry and Nutrition	FSQ 221	To develop skill for determining various thermal properties such as thermal conductivity, thermal diffusivity, calorific value and specific heat.
Unit Operations in Food Processing-II	FPE 221	To develop skill for designing various pumping systems.
Food Biotechnology	FSQ 222	To gain knowledge about various types of freezers.
Food Refrigeration and Cold Chain	FPE 222	Basic knowledge of computer applications and their implementation in various fields of Food Industries.
Processing of Spices and Plantation Crops	FPT 223	To develop knowledge of toxicants that are associated with both plant and animal foodstuffs that occur as natural constituents and contaminants
Business Management and Economics	FPM 221	To introduce students to methods for evaluating different levels of toxicity in foodstuffs.
Processing Technology of Fruits and Vegetables	FPT 311	To gain knowledge about natural constituents that are toxicants and natural contaminants that act as toxicants
Processing of Meat and Poultry Products	FPT 312	
Instrumental Techniques in Food Analysis	FSQ 311	
ICT Applications in Food Industry	FBM 311	
Food Process Equipment Design	FPE 311	
Food Storage Engineering	FPE 312	
Bakery, Confectionery and Snack Products	FPT 313	
Marketing Management and International Trade	FBM 312	
Processing Technology of	FPT 321	

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Beverages		To acquire knowledge about various types of toxicants, chemistry, their mode of action, significance, food sources, and possible detoxification method.
Food Plant Sanitation	FSQ 321	
Food Packaging Technology and Equipment	FPT 322	
Processing of Fish and Marine Products	FPT 323	
Sensory Evaluation of Food Products	FPT 324	
Food Additives and Preservatives	FSQ 322	
Food Quality, Safety Standards and Certification	FSQ 323	
Instrumentation and Process Control in Food Industry	FPE 321	
Project Preparation and Management	FBM 321	
Communication Skills and Personality Development	FBM 411	
Entrepreneurship Development	FBM 412	
Student READY - Experiential Learning Programme	FPO 411	
Student READY - Research Project	FPO 412	
Student READY - Seminar	FPO 413	
Student READY - Industrial Tour	FPO 421	
Student READY - Internship/In-Plant Training	FPO 422	

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COLLEGE OF POST HARVEST TECHNOLOGY & FOOD PROCESSING

B.Tech. (Dairy Technology) Programme (As per ICAR 5th Dean's Committee Recommendations Report)

Department-wise distribution of Credit Load

Names of Departments

1. Dairy Technology
2. Dairy Engineering
3. Dairy Chemistry
4. Dairy Microbiology
5. Dairy Business Management

DEPARTMENT-WISE COURSES

Dairy Technology

S.N	Discipline	Discipline and Title of the Course	Credit Hours
1	DDT- 211	Market Milk	4 (3+1)
2	DDT- 212	Traditional Indian Dairy Products	3 (2+1)
3	DDT- 213	Fat Rich Dairy Products	3 (2+1)
4	DDT- 214	Condensed & Dried Milks	4 (3+1)
5	DDT- 221	Cheese Technology	5 (3+2)
6	DDT - 222	Ice-cream & Frozen Deserts	3 (2+1)
7	DDT- 311	By Products Technology	3 (2+1)
8	DDT- 312	Packaging of Dairy Products	3 (2+1)
9	DDT- 321	Sensory Evaluation of Dairy Products	3 (2+1)
10	DDT- 322	Food Technology - I	3(2+1)
11	DDT- 421	Dairy Plant Management	2 (1+1)
12	DDT- 422	Waste Disposal & Pollution Abatement	2 (1+1)
13	DDT- 423	Food Technology -II	3 (2+1)
		Total	41 (27+14)

Dairy Engineering

S.N	Discipline	Discipline and Title of the Course	Credit Hours
1	DDE- 111	Workshop Practice	2 (1+1)

2	DDE- 112	Fluid Mechanics	3 (2+1)
3	DDE -113	Engineering Drawing	1 (0+1)
4	DDE- 121	Thermodynamics	2 (1+1)
5	DDE- 122	Heat & Mass Transfer	3 (2+1)
6	DDE -123	Boilers and Steam Generation	2 (1+1)
7	DDE -124	Basic Electrical Engineering	3 (2+1)
8	DDE - 211	Refrigeration & Air-conditioning	3 (2+1)
9	DDE – 212	Dairy Engineering	3 (2+1)
10	DDE – 221	Dairy Process Engineering	3 (2+1)
11	DDE – 311	Instrumentation and Process Control	3 (2+1)
12	DDE – 321	Food Engineering	3 (2+1)
13	DDE – 322	Material Strength & Dairy Machine Design	3 (2+1)
14	DDE – 323	Dairy Plant Design and Layout	2(1+1)
15	DDE – 324	Energy Conservation and Management	2(1+1)
		Total	38 (23+15)

Dairy Chemistry

S.N	Discipline	Discipline and Title of the Course	Credit Hours
1	DDC – 121	Physical Chemistry of Milk	3 (2+1)
2	DDC – 111	Biochemistry	2 (1+1)
3	DDC – 211	Human Nutrition	2 (1+1)
4	DDC – 122	Chemistry of Milk	3 (2+1)
5	DDC – 221	Chemistry of Dairy Products	3 (2+1)
6	DDC – 311	Chemical Quality Assurance	2 (1+1)
7	DDC – 321	Food Chemistry	3 (2+1)
		Total	18 (11+7)

Dairy Microbiology

S.N	Discipline	Discipline and Title of the Course	Credit Hours
1	DDM – 111	Fundamentals of Microbiology	3 (2+1)
2	DDM – 121	Microbiology of fluid milk	2 (1+1)
3	DDM – 222	Microbiology of Dairy Products	2 (1+1)
4	DDM – 221	Starter Cultures and Fermented Milk Products	3 (2+1)
5	DDM – 311	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
6	DDM – 321	Food and Industrial Microbiology	3 (2+1)
		Total	16 (10+6)

Dairy Business Management

S.N	Discipline	Discipline and Title of the Course	Credit Hours
1	DBM – 111	Milk Production Management and Dairy Development	3 (2+1)
2	DBM – 113	Computer and Application Software Packages	2 (1+1)
3	DBM – 121	Economic Analysis	2 (2+0)
4	DBM – 114	Environmental Studies	2 (1+1)
5	DBM – 311	ICT in Dairy Industry and Operation Research	4(2+2)
6	DBM – 221	Fundamentals of Dairy Extension	3 (2+1)
7	DBM – 312	Marketing Management & International Trade	2 (2+0)
8	DBM – 112	Communication Skills	2 (1+1)
9	DBM – 423	Industrial Statistics	2 (2+0)
10	DBM – 421	Entrepreneurship Development and Industrial Consultancy	2 (2+0)
11	DBM – 422	Financial Management and Cost Accounting	3 (2+1)
		Total	27 (19+8)

Semester Wise Distribution of Courses

Semester – I

S.N.	Discipline	Title of the Course	Credit Hours
1	DDE-111	Workshop Practice	2 (1+1)
2	DDE- 112	Fluid Mechanics	3 (2+1)
3	DDE- 113	Engineering Drawing	1 (0+1)
4	DDM – 111	Fundamentals of Microbiology	3 (2+1)
5	DBM – 111	Milk Production Management and Dairy Development	3 (2+1)
6	DBM – 112	Communication Skills	2 (1+1)
7	DBM – 113	Computer and Application Software Packages	2 (1+1)
8	DDC – 111	Biochemistry	2 (1+1)
9	DBM – 114	Environmental Studies	2 (1+1)
		Total	20 (11+9)

Semester – II

S.N	Discipline	Title of the Course	Credit hours
1	DDE – 121	Thermodynamics	2 (1+1)
2	DDC – 121	Physical Chemistry of Milk	3 (2+1)
3	DDE – 122	Heat & Mass Transfer	3 (2+1)
4	DDE – 123	Boilers and Steam Generation	2 (1+1)
5	DDE – 124	Basic Electrical Engineering	3 (2+1)
6	DDM – 121	Microbiology of fluid milk	2 (1+1)
7	DBM – 121	Economic Analysis	2 (2+0)
8	DDC – 122	Chemistry of Milk	3 (2+1)
		Total	20 (13+7)
9	DRW - 121	Student READY Rural Dairy Work Experience Programme-I (Summer Break)	5 (0+5)

Semester – III

S.N	Discipline	Title of the Course	Credit Hours
1	DDT – 211	Market Milk	4 (3+1)
2	DDT – 212	Traditional Indian Dairy Products	3 (2+1)
3	DDE – 211	Refrigeration & Air-conditioning	3 (2+1)
4	DDE – 212	Dairy Engineering	3 (2+1)
5	DDT – 213	Fat Rich Dairy Products	3 (2+1)
6	DDT – 214	Condensed & Dried Milks	4 (3+1)
7	DDC – 211	Human Nutrition	2 (1+1)
		Total	22 (15+7)

Semester – IV

S.N	Discipline	Title of the Course	Credit Hours
1	DDE – 221	Dairy Process Engineering	3 (2+1)
2	DDM – 221	Starter Cultures and Fermented Milk Products	3 (2+1)
3	DDM – 222	Microbiology of Dairy Products	2 (1+1)
4	DDT – 221	Cheese Technology	5 (3+2)
5	DDT – 222	Ice-cream & Frozen Deserts	3 (2+1)
6	DDC – 221	Chemistry of Dairy Products	3 (2+1)
7	DBM – 221	Fundamentals of Dairy Extension	3 (2+1)
		Total	22 (14+8)
8	DRW - 221	Student READY Rural Dairy Work Experience Programme-II (Summer Break)	5 (0+5)

Semester – V

S.N.	Discipline	Title of the Course	Credit Hours
1	DDE - 311	Instrumentation and Process Control	3 (2+1)

2	DDM – 311	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
3	DDT – 311	By Products Technology	3 (2+1)
4	DDT – 312	Packaging of Dairy Products	3 (2+1)
5	DDC – 311	Chemical Quality Assurance	2 (1+1)
6	DBM – 311	ICT in Dairy Industry and Operation Research	4(2+2)
7	DBM – 312	Marketing Management and International Trade	2 (2+0)
		Total	20(13+7)

Semester – VI

S.N.	Discipline	Title of the Course	Credit Hours
1	DDE – 321	Food Engineering	3 (2+1)
2	DDE – 322	Material Strength & Dairy Machine Design	3 (2+1)
3	DDE – 323	Dairy Plant Design and Layout	2 (1+1)
4	DDM – 321	Food and Industrial Microbiology	3 (2+1)
5	DDT – 321	Sensory Evaluation of Dairy Products	3 (2+1)
6	DDT – 322	Food Technology - I	3 (2+1)
7	DDC – 321	Food Chemistry	3 (2+1)
8	DDE – 324	Energy Conservation and Management	2(1+1)
		Total	22 (14+8)

Semester – VII

S.N.	Discipline	Title of the Course	Credit Hours
1	DPT – 411	Student READY In- Plant Training	20 (0+20)
		Total	20 (0+20)

Semester – VIII

S.N.	Discipline	Title of the Course	Credit Hours
1	DDT – 421	Dairy Plant Management	2(1+1)
2	DDT – 422	Waste Disposal and Pollution Abatement	2 (1+1)
3	DDT – 423	Food Technology -II	3 (2+1)
4	DBM – 421	Entrepreneurship Development and Industrial Consultancy	2 (2+0)
5	DBM – 422	Financial Management & Cost Accounting	3 (2+1)
6	DBM – 423	Industrial Statistics	2 (1+1)
7	DEL - 421	Student READY Experiential Learning Module	10 (0+10)
		Total	24 (10+14)

Note – Accordingly above course numbers shall be adopted in the syllabus of B.Tech. (Dairy Technology) programme.

Student READY Program

- In plant Training of six months duration (One semester): 20 (0+20) credit hours
- Rural Dairy Work Experience programme of 10 weeks (0+10) (total 10 credit hours) during summer vacation (spread over 2 or 3 Semester breaks) to be introduced starting from first year. The areas of internship may be:
 - First year: On Milk Production & Procurement to be taken up in State Dairy Federations/Dairy Development Departments/Private Dairies/Animal Husbandry Department/Cattle farm/Progressive dairy farmers
 - Second Year: On Preliminary Dairy Operations to be taken up in Experimental Dairy/Referral lab/Dairy Plants
 - Third year: Exposure to Product manufacturing operations in Dairy & Food Industry or
 - Plant visits in each Dairy Technology course to have Industrial exposure in specialized products like Ice cream, Milk Powders, Cheese, By-products etc. should be made compulsory
- Experiential Learning Module of 10 (5+5) credit hours to run concurrently in the final semester along with the regular courses. This shall include development of Detailed Project Report on setting up of enterprise in the selected areas of product manufacture and Evaluation of the Module.

SYLLABUS

DDE – 111 Workshop Practice

2 (1+1)

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 equipments. *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.

DDE – 112 Fluid Mechanics

3 (2+1)

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. 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 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, 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.

DDE – 113 Engineering Drawing

1 (0+1)

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 rivet 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

DDM – 111 Fundamentals of Microbiology

3 (2+1)

Theory

Overview of history and scope of microbiology: Discovery of Microorganisms and Microscopy (types, working principles and applications); Theories of Biogenesis and abiogenesis; Contributions of Leeuwenhoek, Pasteur, Tyndal, Joseph Lister, Robert Koch, Edward Jenner and Alexander Fleming; Scope and application of microbiology in fields like Dairy, Food, Pharmaceutical, Industrial, Medical and agriculture. *Classification of Microbes*: Microbial classification systems, numerical taxonomy, General properties and principles of microbial classification, Whittaker's five kingdom and Carl Woese's three domain classification system; Systematics of bacteria and Bergey's manual of systematic bacteriology, Phylogenetic tree. *Prokaryotic and Eucaryotic microorganisms*: Structure and functions of prokaryotic cells; Differences between prokaryotes and eukaryotes; Differences between cell wall of Gram positive and Gram negative bacteria; Structure of Archeal cell wall. *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

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types of microorganisms. *Diversity of Microorganisms*: Viruses: Structure and Classification; Bacteriophages; Differences between viruses and bacteria; Fungi: Classification of Fungi; Reproduction in Fungi; Protozoa and algae. *Microbial Ecology and Environmental Microbiology*: Microflora of air, soil and water and Microbes of Extreme environment like Archea. *Basics of Microbial Genetics and Host-Microbe interactions*: DNA as the genetic material, Structure of DNA/ RNA, DNA replication, transcription and translation; Basic concepts of immunology; Role of immune system in governing host- microbe interactions, Microbial Commensalism, Colonization, Infection, Disease and Vaccines

Practical

General instruction for microbiological laboratory. Microscope- simple and compound; Microbiological equipments; 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). Motility of microorganisms - hanging drop technique. Measurement of size of microorganisms by micrometry (ocular and stage). 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.

DBM – 111 Milk Production Management and Dairy Development

3 (2+1)

Theory

Introduction to Animal Husbandry. Distinguishing characteristics of India and exotic breeds of dairy animals and their performance. Systems of breeding and methods of selection of dairy animals. General dairy farm practices - Identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes.

Methods of milking, milking procedure and practices for quality milk production. Dairy farm records and their maintenance. Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises. Common disease problems in dairy animals, their prevention and control. Feed nutrients required by animal body. Feed resources for milk production and their nutritive values. Digestive system of ruminants and measures of feed energy. Nutrients requirements for growth and milk production. Feeding standards, Structure and function of mammary system. Milk secretion and milk let-down. Male and female reproductive system. Estrus and reproductive cycle, Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. Artificial insemination and embryo transfer and their role in animal improvement introduction to biotechniques in dairy animal production.

Practical

Handling and restraining of dairy animals. External body parts and judging of cows and buffaloes. Feeding and management practices of calves. Identification of common feeds and fodders. Preparation of rations for adult animals. Milking of dairy animals and cleaning and sanitation of milking equipments. Identification of reproductive and digestive organs. Demonstration of semen collection, processing and artificial insemination.

DBM – 112 Communication Skills

2 (1+1)

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; Précis writing /Abstracting/Summarizing; Style of technical communication Curriculum vitaé/resumé 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, précis 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.

DBM – 113 Computer and Application Software Packages

2 (1+1)

Theory

History, features, classification and organization and I/O peripheral devices for computers; Features of modern operating systems; number systems and coding schemes; Basics of networking and communications; Internet, email concepts and application, Word-processing and desktop publishing, Electronic spreadsheet basics and operations, Database management system basics and operations; Fundamental of presentation-graphic packages. Recent strides in computing.

Practical

Windows Operating System, Word Processing software operations, Presentation Graphics software operations, Internet Surfing/Email usage, RDBMS software package basic operations, Spreadsheet software package basic operations.

DDC – 111 Biochemistry

2 (1+1)

Theory

Bio-Molecules: General structures, classification and functions of bio molecules-Amino acids, Protein Structure, Carbohydrates, Fats, Lipids, DNA and RNA. *Enzymes*: Activation energy /Transition state & Enzyme Classification, Coenzymes/Co-factors & Enzyme kinetics, Mechanism of enzyme action, Factors effecting enzyme activity, Enzyme inhibition, isozymes & Regulatory Enzymes, Immobilization of enzyme, Ribozymes & 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.

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 MichaelisMenten constant of an enzyme. Estimation of RNA by colorimetric method. Estimation of DNA by colorimetric method. Measurement of proteolysis and lipolysis. Estimation of Vitamin A in Ghee. Estimation of Ascorbic acid in plasma.



DDE – 121 Thermodynamics

2 (1+1)

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.

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

DDE – 121 Physical Chemistry of Milk

3 (2+1)

Theory

Constituents and gross composition of milk of different species and breeds of milch animals, *Colloidal State:* Distinction between true and colloidal solution, lypophilie & lypophobic solution, properties of colloidal system. Properties of colloidal systems, 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. *Liquid State:* Surface tension, surface energy interfacial tension. Surface tension of mixtures. Surface tension of milk and the factors affecting it. 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. Refractive index. Colligative Properties of Dilute Solution: Vapour pressure, Raoult's 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. Aqueous solution of Electrolytes: Electrolytes; non-electrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrausch Law, Electrical conductance of milk. Ionic Equilibria: Dissociation of water, ionic product of water, concept of pH and pOH and their scale. Acids and bases: Bronsted Lewis concepts of acids and bases, dissociation constants of acids and bases. Salt-their hydrolysis. 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, electrochemical cells. Hydrogen, glass and calomel electrodes. Redox system of milk. Nuclear Chemistry: The nature of isotopes, radio isotopes. Half life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclide in milk & milk products. Molecular Spectroscopy: The spectrum of electro magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscope. Mention of mass, NMR spectroscopy.



Practical

Determination of density and specific gravity of milk using pycnometer, 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 PK_{a1} , PK_{a2} and PL. Verification of Lambert Beer Law.

DBM – 114 Environmental Studies

2 (1+1)

Theory

Environmental Science: An introduction, Ecosystem: kinds, structure, characteristics, functioning, Biochemical cycles, Natural resources and their managements, Environmental pollution, Air pollution, Water pollution, Solid waste pollution, Noise pollution, Soil pollution, Radio active pollution, Food processing industry waste and its management, Management of urban waste water, Recycling of organic waste, Recycling of factory effluent, Control of environmental pollution through law, Composting of biological waste and Sewage, uses of water disposal effluent treatment, microbial examination.

Practical

Environment and its analysis, Water quality parameters, collection of sample for pollution study, Determination of pH/acidity/alkalinity from sample, Estimation of dissolved oxygen, Estimation of BOD, Estimation of COD, Estimation of nitrates, Estimation of phosphates, Estimation of pollutant elements, Estimation of heavy/toxic elements, Estimation of lead/ mercury, Visit to industrial sewage disposal unit.

DDE – 122 Heat & Mass Transfer

3 (2+1)

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 & food products. Determination of overall heat transfer co-efficient of: Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy & Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteuriser. 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

DDE – 123 Boilers and Steam Generation

2 (1+1)

Theory

Fuels: Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. *Renewable energy sources:* Concepts, classification, Types and description of renewable energy sources. *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

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 Babcock & Wilcox boiler. Study of different Boiler accessories.

DDE – 124 Basic Electrical Engineering

3 (2+1)

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 Wattmeters. *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 an 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.

DDM – 121 Microbiology of Fluid Milk

2 (1+1)

Theory

Microbes associated with raw milk: Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermophilic and thermophilic bacteria - their morphological and biochemical characteristics and classification. 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. *Sources of contamination and microbial spoilage of raw milk*: Microbial contaminants of raw milk supplies, their sources during various stages of production i.e. milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms and preventive measures. Types of microbial spoilage - souring, curdling, bitter cream, proteolysis, lipolysis, abnormal flavors and discoloration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health. *Concept of clean milk production*: Hygienic milk production system; Cleaning and sanitation

of udder, animal, utensils, equipments 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 lactoperoxidase (LP) system. *Microbiological aspects of fluid milk*: Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal (pulsed field) micro-filtration, bacterofugation, 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 toxic 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 total viable count, coliform and methylene blue reduction time. Enumeration of psychrotrophic, thermophilic, thermotolerant 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 discoloration. 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.

DBM- 121 Economic Analysis

2 (2+0)

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.

DDC – 122 Chemistry of Milk

3 (2+1)

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 -Lactoglobulin. Properties of α -Lactalbumin and β -lactoglobulin, Immunoglobulin 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 Kjeldahl 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.

DDT – 211 Market Milk

4 (3+1)

Theory

Market milk industry in India and abroad: Distinctive features of tropical dairying as compared to those of the tropical climate of developed countries. Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitors, lactoperoxidase system. 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) 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. c) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing. d) Product control in market milk plant. e) Defects in market milk. f) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized, vitaminised and sweet acidophilus milk. g) Manufacture of sterilized milk. h) 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 equipments 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.

DDT – 212 Traditional Indian Dairy Products

3 (2+1)

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, Chhaka and Shrikhand. Visit to industry.

DDE – 211 Refrigeration and Air-Conditioning

3 (2+1)

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 Equipments 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, cryogenes, 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 an 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.

DDE – 212 Dairy Engineering

3 (2+1)

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 & 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. *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. Equipments 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 equipments 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.

DDT – 213 Fat-Rich Dairy Products

3 (2+1)

Theory

Status of fat-rich dairy products in India and abroad. *Cream*: a) Definition & 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 losses 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.

DDT – 214 Condensed and Dried Milk

4 (3+1)

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.

DDC – 211 Human Nutrition

2 (1+1)

Theory

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, Safety aspects of food additives, toxic elements, antibiotics, radionuclides in milk and milk products. Nutraceutical, antioxidants, food toxins, anti-nutritional factors, probiotics and cultured dairy products. Biochemical aspect of post-harvest storage specifically food spoilage. **Practical**

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 programmes (survey based result). (b) Hospitals to observe nutritional deficiencies. Identification of Mono, Di and Polysaccharides. Identification of Proteins (albumin, gelatin, peptone). Planning and preparation of high protein, low fat and specialized diets. Detection of antibiotic/toxin in food products.

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 power, 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 equipments:* Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. *Packaging equipments:* Packaging machines for milk & 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

DDM – 221 Starter Cultures and Fermented Milk Products**3 (2+1)****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 production; 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.

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. *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, WhiteHead& 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, 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).

DDM- 222 Microbiology of Dairy Products

2 (1+1)

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/unripened 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. *Microbiology of Condensed, Evaporated and Dried products*: Type of microorganisms associated with condensed, evaporated and dried products, 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; Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards

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 outbreaks 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; Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards; Active packaging concepts and role in bio-preservation.

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 packaging materials for SPC, Spores and Yeast and mold counts.

DDT – 221 Cheese Technology

5 (3+2)

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; Physical and chemical. Additives and preservatives for cheese making. Rennet preparation and properties, rennet substitutes. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage. 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.

Practical

Familiarization with equipments, accessories and standardization numericals. Study of factors affecting rennet action. 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

DDT – 222 Ice-Cream and Frozen Desserts

3 (2+1)

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, 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. Factory visit.



DDC – 221 Chemistry of Dairy Products**3 (2+1)****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.

DBM – 221 Fundamentals of Dairy Extension**3 (2+1)****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 programmes. 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.

DDE – 311 Instrumentation and Process Control**3 (2+1)****Theory**

Instrumentation scheme & characteristics: Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Definition, Application and types of measurements, instrument classification, Functional elements of an instrument, standards, calibration, introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems. *Introduction to various types of sensors:* Definition, principle of sensing & transduction, classification, selection and applications of Sensors., Measurement of parameter : Measurement of length ,angle, area , temperature , pressure flow , speed, force , torque, vibration , level ,

concentration (conductivity and ph) measurement . Flow measurement using magnetic flow measurement. Piezoelectric transducer. *Micro-sensors and smart sensors*: Construction, characteristics and applications. *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 & 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. Preparation and calibration of thermocouple. Study the construction and working of Bourden pressure gauge. Test and calibration of pressure gauges using dead weight tester. Study the mechanism of pH meter and its electrodes. Study a Proximity sensor. Study the different parts and working of pressure switch. Study the different parts of an indicating instrument. Study of RTD and Thermister. Study of different speed measurement sensor/ instruments. Study of LVDT. Study of level/flow controller. Study of PLC. Visit to a automatic controlled dairy plant.

DDM – 311 Quality and Safety Monitoring in Dairy Industry

3 (2+1)

Theory

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: Changing scenario; Concepts of quality control, quality assurance and food safety; Global quality and food safety standards, Integrated food law, its main features and functions. *Introduction to Food Safety Management System*: Concepts of Quality Management System (QMS)– ISO: 9000:2000; Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques. *Microbiological Risk Analysis Concepts*: Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria and 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. *Rapid Enumeration Techniques*: Enumeration principles and procedure for rapid detection of predominant hygiene indicator organisms and pathogens like *E. coli* (*E. coli* O157:H7), *Salmonella*, *Shigella*, *Staphylococcus aureus*, *Bacillus cereus* and *Listeria monocytogenes*. *Role of Biosensors for monitoring hygiene and safety of dairy foods*: Detection of antibiotic residues in milk –Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test) etc. Detection of aflatoxins, pesticides other inhibitors etc. and their public health importance in dairy foods. *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

Rapid detection of total plate count, yeast and mold counts, Coliform, *E. coli*, Enterococci, Enterobacteriaceae count using D- count and 3M Petrifilm kits. 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 antibiotic residues in milk using Delvo SP, MDR test, Charm assay, Lateral flow assay (ROSA test). Rapid detection of aflatoxin M1/ pesticides residues in milk using Charm Assay, Lateral Flow Assay (ROSA test) / Enzyme Inhibition Assay using Luminometer. 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. Quality evaluation by HACCP in the preparation of dairy products.

DDT – 311 By Product Technology

3 (2+1)

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: 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) *Cooprecipitates:* 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.

DDT – 312 Packaging of Dairy Products

3 (2+1)

Theory

Introduction, Importance of Packaging, History of Package Development, Packaging materials, a) 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, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, 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 equipments (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 prepak and vacuum packaging machines.

DDC – 311 Chemical Quality Assurance

2 (1+1)

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., Application of food safety management system (ISO: 22000). Hazard analysis and critical control points (HACCP) system and its application in dairy industry with respect to chemical quality. 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; labeling 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 contaminants 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.

DBM – 311 ICT in Dairy Industry and Introduction to Operations Research 4 (2+2)

Theory

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making. Modeling 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.

DBM – 312 Marketing Management and International Trade

2 (2+0)

Theory

Concept of marketing; Functions of marketing; concepts of marketing management; scope of marketing management; marketing management. Process; concepts of marketing- mix, elements of marketing- mix. Market Structure and Consumer Buying Behaviour: Concept of market structure, marketing environment, micro and macro environments. Consumers buying behaviour, consumerism. Marketing Opportunities Analysis: Marketing research and marketing information systems; Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning. Allocation and marketing resources. Marketing Planning Process. Product policy and planning: Product-mix; product line; product life cycle. New product development process. Product brand, packaging, services decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing Decisions. Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising; How advertising works; Deciding advertising objectives, advertising budget and advertising message; Media Planning; Personal Selling, Publicity; Sales Promotion. Food and Dairy Products Marketing. International Marketing and International Trade. Salient features of International Marketing. Composition & direction of Indian exports; Trends in International Dairy Trade, International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO)

DDE – 321 Food Engineering

3 (2+1)

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. Prediction 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. Freeze concentration. *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 balanced in analysis of continuous dryers, Classification of driers, tray, vacuum, vacuum band, tunnel, bin, solar, drying, freeze drying, spin flash. *Freeze dehydration*: Heat and mass transfer, Calculation of drying time, Industrial freeze drying. *Other food processing operations and equipments*: Equipment for pulping, fruit juice extraction, blanching, dehulling, size reduction, milling, extrusion and distillation.

Practical

To determine physical properties of food product. To determine viscosity of food product. To study food freezers. To study freeze drier. To determine drying characteristics of food product. To compare various drying methods. To determine juice yield. To compare hot water and steam blanching. To study construction and working of distillation system. To study various size reduction equipments. Visit to cold storage. Visit to food processing plant.

DDE – 322 Material Strength & Dairy Machine Design

3 (2+1)

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.

DDE – 323 Dairy Plant Design And Layout

2 (1+1)

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, siting 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 plan 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 equipments. 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

DDM – 321 Food and Industrial Microbiology

3 (2+1)

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; 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 (B₁₂), 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.



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 Quality 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 and 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.

Theory

Status of food processing industries in India and abroad, magnitude and inter-dependence of dairy and food industry, prospects for future growth in India. 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, equipments 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

DDC – 321 Food Chemistry

3 (2+1)

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 the order of hydrolysis of an ester/carbohydrate and measurement of activation energy; determination of the progress curve obtained during the hydrolysis of P- nitrophenyl phosphate by milk alkaline phosphatase; determination of the Michaelis constant for the digestion of casein by trypsin; Measurement of pH and buffering capacity of different

types of milk; To study the gel formation and gel stability of milk proteins; preparation of a Tris/phosphate/citrate buffer of a given molarity/ionic strength and pH; determination of pH of the buffer; measuring the stability of an oil-in-water emulsion stabilised by milk proteins; foaming capacity and foam stability of caseins/whey proteins; drawing of an adsorption isotherm of water on casein

DDE – 324 Energy Conservation and Management

2 (1+1)

Theory

Introduction: Potential and opportunities 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 & 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 & 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 equipments: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying & 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.



Practicals

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 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 Students Experimental Dairy Plant (SEDP-DSc College, Hebbal).

Student READY Rural Dairy Work Experience Program*

20

Student READY Rural Dairy Work Experience Program-I (Summer Break after II semester) of 5 weeks with credit load of 0+5 credit hours to provide exposure to the students to the areas on Milk Production & Procurement to be taken up in State Dairy Federations/Dairy Development Departments/Private Dairies/Animal Husbandry Department/Cattle farm/Progressive dairy farmers.

Student READY Rural Dairy Work Experience Program-II (Summer Break after IV semester) of 5 weeks with credit load of 0+5 credit hours for exposure on Preliminary Dairy Operations to be taken up in Experimental Dairy/Referral lab/Dairy Plants / Exposure to Product manufacturing operations in Dairy & Food Industry.

Semester-VII

Student READY In-Plant Training in Seventh Semester of 24 weeks with credit load of 0+20 credit hours. Plant visits and involvement in processing and manufacturing of value added products in each Dairy Technology course to have Industrial exposure in specialized products like Market Milk, Ice Cream, Milk Powders, Cheese, By-products etc. should be made compulsory

Note - * Course number for Student Ready Programme is given in concerned semesters.

DDT – 421 Dairy Plant Management

2 (1+1)

Theory

Production Management: Definition, Function and structure of Production Management, Production planning & 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:* Energy conservation and Auditing, 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 & 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 & Break-down maintenance:* Spare parts inventory, tools & lubricants, etc. *Food hygiene:* personnel hygiene, plant hygiene, water quality, etc.

Practical

Flow process charts of different milk products. Identification of steps of material losses on dairy plants. Identification of hazardous processes and equipments, safety and precautions. Identification and uses of common lubricants.

DDT – 422 Waste Disposal and Pollution Abatement

2 (1+1)

Theory

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. *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

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.

DDT – 423 Food Technology-II

3 (2+1)

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.

DBM – 421 Entrepreneurship Development and Industrial Consultancy**2 (2+0)****Theory**

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business/ entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/SSIs. Export and Import. Policies relevant to dairy sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of dairy inputs industry. Characteristics of Indian dairy processing and export industry. Social Responsibility of Business. *Industrial Consultancy:* Dairy plant management system- milk procurement from the rural milk producer, milk processing and products manufacturing. Pricing and marketing of milk and milk products. Survey on milk production potential and marketed surplus of milk for setting up of milk plants. Recruitment and training of manpower, Estimation of costs of product manufacture and energy utilization in food processing plants. Sources of finance for setting up of dairy farms and processing plants/ units. Guidelines for obtaining ISO/HACCP certification for dairy plants. Assessment of entrepreneurial skills and characteristics for successful entrepreneur. Consumer opinion surveys. Pricing of milk and milk products. Preparation of feasibility reports for setting of dairy farms, composite milk plants, collection centers, chilling units and processing units.

DBM – 422 Financial Management and Cost Accounting**3 (2+1)****Theory**

Introduction: Definition, scope and objectives of financial management. Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting. Double 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 & retained earning, 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 & duration Investment decisions under inflation, Investment decisions under capital rationing. *Project Report;* Feasibility Report Valuation. Working capital management- Concept & determinants of working capital, Estimating working capital needs. Depreciation – Concept and method. Introduction, Definition, Objectives, Common terms.

REGISTRAR
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Costing: Essentials of sound costing system. Different methods of costing, elements of cost: Labour-recording of time, idle time, methods of remunerating labour, Premium & 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 & storekeeping, scope & importance, purchase procedure, types of purchase, location of stores & 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

2 (1+1)

DBM – 423 Industrial Statistics

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 & attributes

College of Technology

SARDAR VALLABHBHAI PATEL UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, MEERUT- 250 110

B.Tech Agri. Engg.

Duration
Minimum Eligibility, Curriculum

Four academic years (8 semesters)

<http://www.svpuat.ac.in>

/Structure & other details:

PROGRAMME OUTCOMES (POs)

1. To provide students with a comprehensive knowledge in mathematical, scientific and agricultural engineering fundamentals to solve the engineering and farmers related problems and also to pursue higher studies.
2. To provide students experience for planning as well as conducting experiments/ projects in modern engineering laboratories including farmer's friendly technologies and computer based simulation experiments, integrating the significance of experimental data and properly reporting the results.
3. To develop ability of the students to analyze data and technical concepts for application to product design and/or solving real field problems.
4. To make the students familiar with latest and contemporary professional knowledge in the field of agricultural engineering including managerial skills and ethics required for emerging technologies, global economy and also to foster other skills required for grooming them into good professionals.
5. To prepare the students for their successful career in industry/scientific institutions/ technology transfer organizations and also to meet the challenges at national and international levels.
6. Developing Critical and Analytical Thinking Abilities: Critical thinking in academics, presentations, research and professional alliances relies heavily on one's ability to be creative.
7. Developing Entrepreneurship Acumen: Helps to prepare students for research/ managerial roles and as entrepreneurs.
8. Developing skills to solve real-world Engineering problems: Equips students to demonstrate the capabilities required to apply cross-functional knowledge and technologies in solving real-world engineering problems.
9. Appropriate techniques: Enables students to demonstrate use of appropriate techniques to effectively manage academic and research challenges.
10. Practical exposure: Providing an opportunity for the students to gain practical exposure towards the workplace of engineering laboratory and make them industry ready.
11. Decision Making: Equip students with techniques of analyzing and interpretation of the research data which is used in Decision Making.
12. To develop students with the ability to analyze various functional issues affecting the engineering. Organization and acquiring conceptual clarity of various functional areas of engineering field.
13. The students understand the ethical challenges and choices in a engineering unit setting and develop ability to evolve strategies for research/ organizational benefits.
14. To inculcate in students the ability to gain multidisciplinary knowledge through seminar reports, case study analysis, Research projects and industrial training and Organizational visits.
15. Demonstrate ability to work in Groups and acquire leadership quality required in their career.



REGISTRAR
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COURSE OUTCOMES (COT)

Subject	Subject Code	Course Outcomes
Engineering Mathematics-I	TBS- 111	The objective of this course is to familiarize agricultural engineers with techniques in Statistics, Differentiation with its applications and Matrices. It aims to equip the students with standard concepts and tools from intermediate to advanced level that will enable them to tackle the more advanced level of mathematics and applications that they would find useful in their disciplines.
Engineering Physics	TBS -112	1.To explain the distribution of energy in black body radiation and to understand the difference in particle and wave nature with explanation of Compton effect and Schrodinger wave equation. 2.To understand the behavior of waves through various examples/applications of interference and diffraction phenomenon and the concept of grating and resolving power. 3.To know the functioning of optical fiber and its properties and applications. To understand the concept, properties and applications of Laser. 4.To know the properties and applications of superconducting materials and nano materials.
Engineering Chemistry	TBS- 113	1. To enable the students to understand about the Chemistry of Atomic and Molecular structure, Chemistry of advanced Materials like Liquid crystals, nano materials, Graphite & fullerenes and Green Chemistry. 2. To enable the students to understand and apply the detailed concepts of spectroscopic techniques and stereochemistry to identify the compounds, element etc..
Principles of Soil Science	TAG -111	1. Understanding the concept of soil and soil profile. 2. Understanding the concept of physico-chemical properties of soil. 3. Analyzing the effect of pH on soil nutrient availability. 4. Identifying the macro and microorganisms and their effect on soil. 5. Evaluating the physical and chemical properties of soil.
Surveying and Leveling	CED- 111	1. Describe the function of surveying and work with survey instruments, take observations, and prepare plan, profile, and cross-section and perform calculations. 2. Calculate, design and layout horizontal and vertical curves. 3. Operate a total station and GPS to measure distance, angles, and to calculate differences in elevation. Reduce data for application in a geographic information system.
Engineering Mechanics	CED- 112	After completing this course, the students should be able to understand the various effect of force and motion on the engineering design structures.
Engineering Drawing	MED- 111	1.Use scales and draw projections of objects. 2. Explain views of solids and their sectional surfaces. 3. Analyze and draw isometric projections of objects. 4. Demonstrate orthographic representation of perspective views using modern tools. 5. Apply AutoCAD software for creation of engineering drawing and models
Heat and Mass Transfer	MED- 112	Upon completion of the course, the student will be able to: 1: Understand the basic modes of heat and mass transfer. 2: Apply principles of heat and mass transfer to predict transfer coefficients 3: Analyze working of various heat transfer equipment 4: Design heat and mass transfer equipment.
Engineering Mathematics-II	TBS-121	1. Understand and apply the tools of differentiation of functions of complex variables that are used in various techniques dealing with engineering problems. 2. To deal with vector calculus that is required to graduate engineers. 3. Understand and apply the effective mathematical tools for the solution of differential equations of model physical processes 4. Apply the tool of Fourier series and multivariable partial Differential equations for learning advanced Engineering Mathematics 5. Apply the application of



		partial Differential equations in heat and wave equations
Environmental Science and Disaster Management	TAG-122	Upon completion of this course, students will acquire knowledge about 1. Understand the natural environment and its relationships with human activities. 2. Characterize and analyze human impacts on the environment. 3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems. 4. Capacity to integrate knowledge and to analyses, evaluate and manage the different public health aspects of disaster events at a local a and global levels. 4. Capacity to obtain, analyses, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios.
Entrepreneurship Development and Business Management	TAG-121	Clarity about the business idea. Market potential for the product or service. Skills in preparing business plan. Conducting project feasibility study.
Fluid Mechanics and Open Channel Hydraulics	CED-121	1. Understand the broad principles of fluid statics, kinematics and dynamics 2. Understand definitions of the basic terms used in fluid mechanics 3. Understand classifications of fluid flow 4. Apply the continuity, momentum and energy principles 5. Apply dimensional analysis
Strength of Materials	CED-122	1. Describe the concepts and principles of stresses and strains 2. Analyze solid mechanics problems using classical methods and energy methods 3. Analyze structural members subjected to combined stresses 4. Calculate the deflections at any point on a beam subjected to a combination of loads 5. Understand the behavior of columns, springs and cylinders against loads.
Workshop Technology and Practices	MED-121	1. Use various engineering materials, tools, machines and measuring equipments. 2. Perform machine operations in lathe and CNC machine. 3. Perform manufacturing operations on components in fitting and carpentry shop. 4. Perform operations in welding, moulding, casting and gas cutting. 5. Fabricate a job by 3D printing manufacturing technique
Theory of Machines	MED-122	1. To identify and enumerate different link based mechanisms with basic understanding of motion 2. To understand and illustrate various power transmission mechanisms using suitable methods 3. To understand and illustrate various power transmission mechanisms using suitable methods 4. To design and evaluate the performance of different cams and followers.
Web Designing and Internet Applications	CSE-121	1. Understand principle of Web page design and about types of websites 2. Visualize and Recognize the basic concept of HTML and application in web designing. 3. Recognize and apply the elements of Creating Style Sheet (CSS). 4. Understand the basic concept of Java Script and its application. 5. Introduce basics concept of Web Hosting and apply the concept of SEO
Principles of Horticultural Crops and Plant Protection	TAG-211	1 Understanding the concepts of horticulture including the management of water, weed, fertility, and market chain. 2 Explaining the vegetable gardens, orchards and their management practices. 3 Analyzing the weed management, fertility management in production of Horticultural crops.
Principles of Agronomy	TAG-212	1. Understanding the scope and practices of Agronomy. 2. Demonstrating the methods of irrigation, crop rotation and weeding in different crops. 3. Applying the method of seed sowing, tillage, weeding, irrigation, and crop management in problematic areas. 4. Analyzing the effect of weed-crop competition on agricultural productivity.
Communication Skills and Personality Development	TBS-211	1. Write professionally in simple and correct English. 2. Demonstrate active listening with comprehension, and the ability to write clear and well structured emails and proposals. 3. Learn the use of correct body language and tone of voice to enhance communication.

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		<p>4. Acquire the skills necessary to communicate effectively and deliver presentations with clarity and impact</p> <p>5. Understand and apply some important aspects of core skills, like Leadership and stress management.</p>
Engineering Mathematics-III	TBS- 212	<p>1. Remember the concept of Laplace transform and apply in solving real life problems. 2. Understand the concept of Fourier and Z – transform to evaluate engineering problems 3. Remember the concept of Formal Logic ,Group and Rings to evaluate real life problems 4. Apply the concept of Set, Relation, function and Counting Techniques 5. Apply the concept of Lattices and Boolean Algebra to create Logic Gates and Circuits, Truth Table, Boolean Functions, Karnaugh Map</p>
Soil Mechanics	CED-211	<p>1. Classify the soil and determine its Index properties. 2. Evaluate permeability and seepage properties of soil. 3. Interpret the compaction and consolidation characteristics & effective stress concept of soil. 4. Determine the vertical and shear stress under different loading conditions and explain the phenomenon of soil liquefaction. 5. Interpret the earth pressure and related slope failures.</p>
Design of Structures	CED-212	<p>1. Explain type of structures and method for their analysis. 2. Analyze different types of trusses for member forces. 3. Compute slope and deflection in determinate structures using different methods. 4. Apply the concept of influence lines and moving loads to compute bending moment and shear force at different sections. 5. Analyze determinate arches for different loading conditions.</p>
Machine Design	MED-211	<p>1. To identify and enumerate different link based mechanisms with basic understanding of motion</p> <p>2. To understand and illustrate various power transmission mechanisms using suitable methods</p> <p>3. To understand and illustrate various power transmission mechanisms using suitable methods.</p>
Thermodynamics, Refrigeration and Air Conditioning	MED-212	<p>1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system. 2. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems</p> <p>3. Present the properties, applications and environmental issues of different refrigerants. 4. Calculate cooling load for air conditioning systems used for various 5. Operate and analyze the refrigeration and air conditioning systems.</p>
Electrical Machines and Power Utilization	ECE-211	<p>1. Analyze the various principles & concepts involved in Electromechanical Energy conversion. 2. Demonstrate the constructional details of DC machines as well as transformers, and principle of operation of brushless DC motor, Stepper and DC Servo motors. 3. Evaluate the performance and characteristics of DC Machine as motor and as well as generator. 4. Evaluate the performance of transformers, individually and in parallel operation. 5. Demonstrate and perform various connections of three phase transformers.</p>
Building Construction and Cost Estimation	CED-221	<p>1. Identify various building materials and to understand their basic properties. 2. Understand the use of non-conventional civil engineering materials. 3. Study suitable type of flooring and roofing in the construction process. 4. Characterize the concept of plastering, pointing and various other building services. 5. Exemplify the various fire protection, sound and thermal insulation techniques, maintenance and repair of buildings.</p>
Auto CAD Applications	MED-221	<p>Upon completion of the course, the student will: Become familiar with the Auto CAD user interface. Understand the fundamental concepts and features of Auto CAD. Use the precision drafting tools in Auto CAD to develop accurate technical drawings.</p>

Applied Electronics and Instrumentation	ECE-221	1. Recognize the evolution and history of units and standards in Measurements. 2. Identify the various parameters that are measurable in electronic instrumentation. 3. Employ appropriate instruments to measure given sets of parameters. 4. Practice the construction of testing and measuring set up for electronic systems. 5. To have a deep understanding about instrumentation concepts which can be applied to Control systems. Relate the usage of various instrumentation standards.
Tractor and Automotive Engines	FME- 221	1. Understand the working and operating principles of different systems of I.C. engines. 2. Identify the different components of I.C. engines. 3. Relate and analyze the working of different systems of engine. 4. Comprehend the terminologies and efficiency of I.C. engines with numerical specific to tractor engine.
Engineering Properties of Agricultural Produce	PFE- 221	1. Understand the basics of engineering properties of foods. 2. Analyse the design concepts for different food instruments / equipment 3. Implement the engineering properties in processing machines.
Watershed Hydrology	SWE- 221	1. Understand the basic concept of hydrological cycle and its various phases. 2. Understand the concept of runoff and apply the knowledge to construct the hydrograph. 3. Apply the various methods to assess the flood. 4. Assess the quality of various forms of water and their aquifer properties. 5. Understand the well hydraulics and apply ground water modelling techniques.
Irrigation Engineering	IDE- 221	1. Compute the discharge at the head of distributaries required in its command, capacity of a reservoir, evapo-transpiration, irrigation requirement of crop, water requirement of crop, irrigation interval, irrigation period and irrigation efficiencies by applying the knowledge of crop period, crop area, duty, delta and irrigation intensity. 2. Analyse the data related to irrigation water measurement through irrigation water measuring structures to estimate the discharge of water measuring structures such as weirs, flumes and notches. 3. Design the field channels, Regime Channels, border irrigation, fundamentals of check basin and furrow irrigation. 4. Solve the real world problem of land grading by calculating the formation levels of grid points of a particular area where land grading operation is to be done
Sprinkler and Micro Irrigation Systems	IDE-222	1. Apply: basic understanding of Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems. Micro Irrigation Systems: chemical treatment, Fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection. 2. Compute: uniformity coefficient and pattern efficiency, wetting patterns, irrigation requirement, emitter selection. 3. Analyse: performance evaluation of sprinkler and drip irrigation systems. necessary steps for proper operation of a drip irrigation system. 4. Design: sprinkler and drip irrigation system: Main, Sub-main, Lateral
Fundamentals of Renewable Energy Sources	REE-221	1. Understand the fundamentals of various Renewable Energy Sources and their applications 2. Analyze the different approaches of solar energy collection, storage and power generation. 3. Compute the power generation from solar energy and wind power systems 4. Explain the construction and working principle of different Bio energy conversion systems
Skill Development Training-I summer Break June-July after 4 th		Effectively communicate through verbal/oral communication and improve the listening 1. Skills Write precise briefs or reports and technical documents 2. Actively participate in group discussion / meetings / interviews and prepare 3. Deliver presentations . Become more effective individual through goal/target setting, self motivation 4. Practicing creative thinking. Function

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Semester (Student READY)		effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality
Tractor Systems and Controls	FME- 312	1. Understand construction & working of different systems of tractor clutch transmission & power flow in a tractor. 2. Analyze problems related clutch, gear box, traction, traction mechanics. 3. Relate human factors that are considered for the design of controls on tractors. 4. Explain construction, operation and working principles of different systems of tractor in general.
Farm Machinery and Equipment-I	FME- 311	1. Apply the knowledge of various farm machines used for farming operations and land development works including their material of constructions 2. Calculate the forces acting on the tillage machine components, draft requirement of the various machines and economics of operating these machines 3. Compute the size of tractor required to operate the machines 4. Select the types of machines required for specific field operations and material for their construction
Agricultural Structures and Environmental Control	PFE- 311	1. To know basics of design of various agricultural structures for animals and human beings. 2. Analyze impact of environmental, ecological and sanitation on livestock and human beings. 3. Compute cost of agricultural structures related to animals and human beings. 4. Apply real world problems of planning, design and execution of agricultural structures related to animals and human beings
Post Harvest Engineering of Cereals, Pulses and Oil Seeds	PFE- 312	1. To impart knowledge on various process technologies for cereals, pulses, oilseeds and their handling and conveying equipment 2. To understand the working principles and selection procedure of different machineries used for processing of cereals, pulses and oilseeds 3. To compute different unit operations in processing, storage and value addition of cereals, pulses and oilseeds 4. To analyze the different uses of byproducts obtained from cereals, pulses and oilseed
Soil and Water Conservation Engineering	SWE- 311	1. Understand the importance of soil & water conservation (SWC) measures for the control of soil erosion and thereby enhancing agricultural productivity 2. Compute various design components of terraces, bunds etc. 3. Select appropriate soil and water conservation measures at a location 4. Apply the knowledge on engineering for design of SWC projects in watersheds
Watershed Planning and Management	SWE- 312	1. Understand the concept of watershed as a unit of planning and development of agriculture on a watershed scale to enhance agricultural productivity 2. Compute various parameters of hydrologic and geomorphologic characteristics of watershed 3. Formulate the appropriate watershed management plan for implementation 4. Apply the engineering knowledge and skill for designing various SWC projects in watersheds
Drainage Engineering	IDE- 311	1. Apply: basic understanding of impact of Water logging objectives of drainage, familiarization with drainage problems of India and state; sub-surface drainage: purpose and benefits, 2. Compute: different drainage design parameters-hydraulic conductivity, drainable porosity, water table observation wells and piezometers. 3. Analyse Hooghoudt, Ernst drain spacing equations drainage materials, drainage pipes, drain envelope layout, construction & installation of drains; drainage structures; vertical drainage; bio-drainage; mole drains reclamation of saline & alkaline soils. Cost analysis of surface & sub-surface systems 4. Design: surface and subsurface drainage systems as well as gravel envelop for different soil and water conditions and conjunctive use of fresh and saline water
Renewable Power Sources	REE- 311	1. Understand the working and operating principles of different Renewable Energy Sources. 2. Explain the construction, operation and working principle

		of biomass/MSW based power generation systems. 3. Design the power generation systems from solar energy, wind energy and small hydropower. 4. Analyze the working of different alternative energy sources
Skill Development Training-I (Student READY) Registration only	AGE-311	Effectively communicate through verbal/oral communication and improve the listening 1. skills Write precise briefs or reports and technical documents 2. Actively participate in group discussion / meetings / interviews and prepare 3. & deliver presentations . Become more effective individual through goal/target setting, self motivation and 4. practicing creative thinking. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge 5. of team work, Inter-personal relationships, conflict management and leadership quality
Computer Programming and Data Structures	CSE-321	1. Perform operations on various discrete structures such as sets, functions, relations, and sequences. 2. Ability to solve problems using Counting techniques, Permutation and Combination, Recursion and generating functions. 2. Apply algorithms and use of graphs and trees as tools to visualize and simplify Problems.
Farm Machinery and Equipment-II	FME-321	1. Understand the principles & types of cutting mechanisms. Construction & adjustments of shear and Impact-type cutting mechanisms. 2. Crop harvesting machinery: Mower, Reaper, windrower, reaper binder & forage harvester. Forage chopping & handling equipment. 3. Apply threshing mechanics & various types of threshers. Straw combines & grain combines, Maize harvesting & shelling equipment, Root crop harvesting equipment - potato, Groundnut etc. 4. Understand Cotton picking & Sugarcane harvesting equipment. Principles of fruit harvesting tools & machines.
Dairy and Food Engineering	PFE-322	1. Apply the knowledge of different unit operations in dairy industries 2. Analyses the dairy plant design problems 3. Compute the problems based on different unit operations. 4. Understand the change in product behavior during different unit operations
Post Harvest Engineering of Horticultural Crops	PFE-321	Use the different types of sorting, grading, peeling, slicing, blanching and other equipment for processing of fruits and vegetables. 1. Identify the suitable equipment, materials, and methods for storage, processing, packaging, and value addition of fruits and vegetables. 2. Develop at least types of value-added products from fruits and vegetables. 3. Understand the technical and management aspects of the operation of fruits and vegetable processing industries.
Water Harvesting and Soil Conservation Structures	SWE-321	1. Understand the procedures/steps for designing various water harvesting and soil conservation structures/measures 2. Design various components of drop, inlet spillways, farm pond, earth embankments etc. 3. Select appropriate water harvesting and soil conservation structures at a location. 4. Apply the knowledge on engineering for design of water harvesting and soil conservation structures in watersheds
Groundwater, Wells and Pumps	IDE- 321	1.Study of the Occurrence and movement of ground water and their classification; water lifting devices and their classification. 2. Apply the knowledge of ground water movement and pumps in computation of aquifer parameters and pumping, parameters, respectively. 3. Analyze well test data for determination of aquifer parameters; and pumping data for Efficiencies, performance, power requirement of different types of pumps. 4. Analyze well test data for determination of aquifer parameters; and pumping data for Efficiencies, performance, power requirement of different types of pumps. 5. Design of wells (open and tube well);different types of pumps (radial pump impeller, volute and diffuser casings)


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Tractor and Farm Machinery Operation and Maintenance	FME-322	Students will be able to identify different systems of tractor and know about their functioning. 1. Students will be able attach various agricultural machinery with the tractor and can do the adjustments required for operation. 2. Students will be able to do periodic maintenance of various components of tractor and machinery. 3. Student will be able to learn how to replace the agricultural machinery components like furrow opener, plough bottom and rotavator blade
Bio-energy Systems: Design and Applications	REE-321	1. Apply the knowledge of various design perspectives in construction and working of different bio energy systems and their applications. 2. To study biomass production techniques. 3. Analyze the working of different power generation system. 4. Understand the biodiesel and bio-hydrogen production techniques and Assessment of environmental aspect of bio energy
Skill Development Training-II (Student READY) Registration only	AGE-411	Effectively communicate through verbal/oral communication and improve the listening 1. skills Write precise briefs or reports and technical documents 2. Actively participate in group discussion / meetings / interviews and prepare 3. & deliver presentations . Become more effective individual through goal/target setting, self motivation and 4. practicing creative thinking. Function effectively in multi-disciplinary and heterogeneous teams through the knowledge 5. of team work, Inter-personal relationships, conflict management and leadership quality
10- weeks Industrial Attachment /Internship (Student READY)	AGE-412	Understand the Organizational Structure of a company. Develop work habits and attitudes necessary for job success (technical competence, professional attitude, organization skills etc.) Develop written communication and technical report writing skills.
10- weeks Experiential Learning On campus (Student READY)	AGE-413	Throughout the experiential learning process, the learner is actively engaged in posing questions, investigating, experimenting, being curious, solving problems, assuming responsibility, being creative and constructing meaning. Learners are engaged intellectually, emotionally, socially, soulfully and/or physically.
Educational Tour (Registration only)	AGE-414	Enhances knowledge and understanding. ... Promotes teamwork and social skills. ... Encourages independent learning. ... Promotes creativity and critical thinking. ... Provides a break from the monotony of classroom learning. ... Exposure to new cultures and environments.
Remote sensing & GIS applications (Elective course)	SWE-424	1. Understand the basic concepts of RS, GIS & Photogrammetry. 2. Acquaint with components & scanning techniques of RS & GIS. 3. Analyse digital images & classifications using various principles. 4. Apply the knowledge of RS & GIS techniques for natural resource management
Farm Machinery Design & Production (Elective course)	FME-423	1. To identify the need of timely harvesting of crops in India. Also equip the students with technical knowledge and skills required for the operation, maintenance and evaluation of harvesting, threshing and land preparation (heavy) machinery needed for agricultural farms. 2. To abreast the students with mathematical, experimental and computational skills for solving different field problems. 3. To develop skills in the students required to develop and modification of indigenous harvesting machines/methods as per the need of the area and farmers 4. give a brief introductory idea of importance of testing of agricultural machines and tractor


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Management of Canal Irrigation Systems (Elective course)	IDE-421	1. Have knowledge and skills on crop water requirements. 2. Understand the methods and management of irrigation. 3. Gain knowledge on types of impounding structures.
Project Planning and Report Writing (Student READY)	AGE-421	Recognise how to plan and complete reports for maximum impact. Understand the Who, What, When, Where, Why and How. Identify the different measures of readability. Know how to tailor a report for a specific audience.

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COLLEGE OF HORTICULTURE

Undergraduate

Degree Programme :- B.Sc. (Hons.) Horticulture

PROGRAMME OUTCOMES (POS)

- PO-1: To promote professional skills and knowledge through meaningful hands on experience.
- PO-2: To provide an opportunity to the students to understand the rural setting in relation to agriculture and allied activities.
- PO-3: To make the students familiar with socio-economic conditions of the farmers and their problems.
- PO-4: To impart diagnostic and remedial knowledge to the students relevant to real field situations through practical training.
- PO-5: To develop communication skills in students using extension teaching methods in transfer of technology.
- PO-6: To acquaint students with on-going extension and rural development programmes.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

- PSO-1: To impart knowledge in various aspects of horticulture through theory and practical knowledge.
- PSO-2: To expose the students to industrial environment, which cannot be simulated in the university.
- PSO-3: To familiarize the students with various materials, machines, processes products and their applications along with relevant aspects of shop management.
- PSO-4: To make the students understand the psychology of the workers and approach to problems along with the practices followed at factory.
- PSO-5: To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
- PSO-6: Understand the impact of the professional agricultural solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PSO-7: To understand and analyze the current events and issues that are occurring in agriculture and how they affect futuristic agriculture.
- PSO-8: This programme will also help students to enhance their employability for jobs in different sectors.

Course Outcomes (COs)

Discipline / Course title	Course No	Course Outcomes
Fundamentals of Horticulture	HFS-111	CO1. After completion of the degree programme, the students will be able to transfer knowledge of horticulture in the field of agriculture research especially in horticulture including fruits plants and their management.
Tropical and sub-tropical fruits	HFS-121	
Plant Propagation and Nursery Management	HFS-123	
Growth and Development of Horticultural Crops	HFS-124	
Temperate Fruit crops	HFS-211	CO2. The students will be acquainted with the

Weed Management in Horticultural Crops	HFS-212
Plantation Crops	HFS-221
Breeding of Fruit and Plantation Crops	HFS-222
Dryland Horticulture	HFS-223
Introductory Agro-forestry	HFS-311
Orchard and Estate Management	HFS-312
Apiculture, Sericulture and Lac culture	HFS-322
Tropical and Subtropical Vegetable crops	HVS-121
Temperate Vegetable crops	HVS-211
Spices and Condiments	HVS-221
Precision Farming and Protected Cultivation	HVS-222
Breeding of Vegetable Tuber and Spice Crops	HVS-311
Potato and Tuber Crops	HVS-312
Seed Production of Vegetable Tuber and Spice Crops	HVS-321
Fundamentals of Food Technology	HPT-211
Postharvest Management of Horticultural Crops	HPT-321
Processing of Horticultural Crops	HPT-322
Principles of Landscape Architecture	HFL-111
Commercial Floriculture	HFL-211
Ornamental Horticulture	HFL-221
Medicinal and Aromatic Crops	HFL-311
Breeding and Seed Production of Flower and Ornamental Crops	HFL-321
Fundamentals of Entomology	HPP-211
Diseases of Fruit, Plantation and Medicinal and Aromatic Crops	HPP-212
Fundamentals of Plant Pathology	HPP-213
Nematode Pests of Horticultural Crops and their Management	HPP-214
Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	HPP-221
Diseases of Vegetable, Ornamental and Spice Crops	HPP-311
Insect Pests of Vegetable, Ornamental and Spice Crops	HPP-321
Fundamentals of Soil Science	HNM-111
Environmental Studies and Disaster Management	HNM-121
Water Management in Horticultural Crops	HNM-122
Soil Fertility and Nutrient	HNM-123

production technology of tropical and dryland fruit production.

CO3. To make them aware of the intercultural operation of fruit crops and also to study the economics these tropical and dryland fruit crops along with the knowledge of diseases, pests and physiological disorders, mineral deficiency problems maturity indices for harvesting the crops and economics of the tropical and dryland fruit crops.

CO4. The students will know about the package and practices of subtropical and temperate fruit crops along with the knowledge of diseases, pests and physiological disorders, mineral deficiency problems maturity indices for harvesting the crops and economics of the subtropical and temperate fruit crops.

CO5. Development innovative agro- techniques to enhance the production and productivity of subtropical and temperate fruit crops.

CO6. After gaining experience, they will increase farmers' income through adopting hi-tech horticulture.

CO7. The students will know about biodiversity, conservation issues and exploitation of biological diversity through crop management.

CO8. The students will be acquainted understanding the biodiversity, centres of origin of cultivated fruit crops.

CO9. The students will be acquainted with the quantify economic importance of plants in managed ecosystems and the impact of horticultural crops in food systems.

CO10. To make them aware about interculture operation for setting up of model nurseries in rural areas for availability of quality planting material.

CO11. The students will know about life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony and chimeras.

CO12. The students will know about the principles,



Management		theoretical aspects and developing skills in biotechnology of horticultural crops.
Farm Power and Machinery	HNM-221	
Soil, Water and Plant Analysis	HNM-222	CO13. To make them aware about callus culture, cell division, differentiation, morphogenesis, organogenesis, embryogenesis and physiology of hardening.
Organic Farming	HNM-311	
Introduction to Major Field Crops	HNM-312	CO14. To make them aware about canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruit and tropical or subtropical fruit crops.
Agro-meteorology and Climate Change	HNM-313	
Introductory Crop Physiology	HBS-111	
Introductory Microbiology	HBS-112	
Elementary Statistics and Computer Application	HBS-113	
Principles of Plant Breeding	HBS-114	
Principles of Genetics and Cytogenetics	HBS-121	
Elementary Plant Biochemistry	HBS-115	
Elementary Plant Biotechnology	HBS-211	
Economics and Marketing	HSS-111	
Communication Skills and Personality Development	HSS-112	
Information and Communication Technology	HSS-121	
Fundamentals of Extension Education	HSS-323	
Horti-Business Management	HSS-321	
Entrepreneurship Development and Business Management	HSS-322	
Physical and Health Education (NC)	NSO-121	
NSS/NCC(NC)	NSO-114/ NSO-115	

AGRONOMY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
AGRON 501*	Modern concepts in crop production	3+0
AGRON 502*	Principles and practices of soil fertility and	2+1
AGRON 503*	Nutrient management Principles and practices of weed management	2+1
AGRON 504*	Principles and practices of water management	2+1
AGRON 505	Agrometeorology and crop weather forecasting	2+1
AGRON 506	Agronomy of major cereals and pulses	2+1
AGRON 507	Agronomy of oilseed, fibre and sugar crops	2+1
AGRON 508	Agronomy of medicinal, aromatic and under	2+1
AGRON 509	Utilized crops Agronomy of fodder and forage crops	2+1
AGRON 510	Agrostology and agroforestry	2+1
AGRON 511	Cropping systems	2+0
AGRON 512	Dryland farming	2+1
AGRON 513	Principles and practices of organic farming	2+1
AGRON 591	Master's seminar	1+0
AGRON 599	Master's research	20
AGRON 601	Current trends in agronomy	3+0
AGRON 602	Crop ecology	2+0
AGRON 603	Crop production and system modeling	2+1
AGRON 604	Advances in crop growth and productivity	2+1
AGRON 605	Irrigation management	2+1
AGRON 606	Advances in weed management	2+0
AGRON 607	Integrated farming systems	2+0
AGRON 608	Soil conservation and watershed management	2+1
AGRON 609	Stress crop production	2+1
AGRON 691	Doctoral seminar I	1+0
AGRON 692	Doctoral seminar II	1+0
AGRON 699	DOCTORAL RESEARCH	45

AGRICULTURE ECONOMICES
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
AG ECON 501*	Micro economic theory and applications	2+0
AG ECON 502*	Macro economics and policy	2+0
AG ECON 503*	Evolution of economic thought	1+0
AG ECON 504*	Agricultural production economics	1+1
AG ECON 505*	Agricultural marketing & price analysis	2+1
AG ECON 506*	Research methodology for social sciences	1+1
AG ECON 507*	Econometrics	2+1
AG ECON 508*	Linear programming	1+1
AG ECON 509*	Agricultural finance and project management	2+1
AG ECON 511	International economics	1+1
AG ECON 512	Institutional economics	1+0
AG ECON 513	Agricultural development policy analysis	2+0
AG ECON 514	Natural resource and environmental economics	1+1
AG ECON 515	Intellectual property management	1+0
AG ECON 516#	Computer applications for agricultural economics	2+1
AG ECON 517	Rural marketing	2+0
AG ECON 518	Commodity futures trading	2+0
AG ECON 591	Master's seminar	1+0
AG ECON 599	Master's research	20
AG ECON 601**	Advanced micro-economic analysis	1+1
AG ECON 602**	Advanced macro-economic analysis	2+0
AG ECON 603**	Advanced econometrics	2+1
AG ECON 604**	Advanced production economics	2+1
AG ECON 605**	Quantitative development policy analysis	1+1
AG ECON 606**	Advanced agricultural marketing and price analysis	2+1
AG ECON 608	Commodity futures trading	2+0
AG ECON 609	Natural resource management	1+1
AG ECON 610	Environmental economics	2+0
AG ECON 691	Doctoral seminar I	1+0
AG ECON 692	Doctoral seminar II	1+0
AG ECON 699	DOCTORAL RESEARCH	45

Compulsory for Master's programme; ** Compulsory for Doctoral programme # Cross-listed with Statistics
The following Basic Supporting courses (5 credits) are recommended for M. Sc. / Ph. D. programmes

M. Sc.

STAT MATHEMATICS FOR AGRICULTURAL ECONOMICS 3
STAT STATISTICAL METHODS FOR SOCIAL SCIENCES 2 Ph. D.

STAT MULTIVARIATE ANALYSIS 2

STAT OPERATIONS RESEARCH 3

*** AGRICULTURE ENGINEERING AND FOOD TECHNOLOGY PROCESSING AND FOOD ENGINEERING**
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
PFE 501*	Transport phenomena in food processing	2+1
PFE 502*	Engineering properties of food materials	2+1
PFE 503*	Advanced food process engineering	2+1
PFE 504*	Unit operations in food process engineering	2+1
PFE 505	Energy management in food processing industries	2+1
PFE 506	Processing of cereals, pulses and oilseeds	2+1
PFE 507	Food processing equipment and plant design	2+1
PFE 508	Fruits and vegetables process engineering	2+1
PFE 509	Meat processing	2+1
PFE 510	Food packaging	2+1
PFE 511	Food quality and safety engineering	2+1
PFE 512	Farm structures and environmental control	1+1
PFE 513	Storage engineering and handling of agricultural products	2+1
PFE 514	Seed drying, processing and storage	2+1
PFE 515	Biochemical and process engineering	2+1
PFE 591	Master's seminar	1+0
PFE 592	Special problem	0+1
PFE 595#	Industry/ institute training	
PFE 599	Master's research	20
PFE 601**	Textural & rheological characteristics of food materials	2+1
PFE 602**	Advances in food processing	3+0
PFE 603	Mathematical models in food processing	3+0
PFE 604	Advances in drying of food materials	2+1
PFE 605	Agricultural waste and by-products utilization	2+1
PFE 691	Doctoral seminar I	1+0
PFE 692	Doctoral seminar II	1+0
PFE 693	Special problem	0+1
PFE 694	Case study	0+1
PFE 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme; ** Compulsory for Doctoral programme # PFE 595 – Minimum of Three Weeks Training

Note: Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing & Food Engineering, Energy in Agriculture, Civil Engineering, Computer Science, Electrical Engineering, Mathematics and Statistics; The contents of some of the identified Minor/Supporting courses have been given.

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AGRICULTURE EXTENSION
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
EXT 501*	Development perspectives of extension education	1+1
EXT 502*	Development communication and information management	2+1
EXT 503*	Diffusion and adoption of innovations	2+1
EXT 504*	Research methods in behavioral sciences	2+1
EXT 505*	E-extension	2+1
EXT 506*	Entrepreneurship development and management in extension	2+1
EXT 507*	Human resource development	2+1
EXT 508	Visual communication	2+1
EXT 509	Participatory methods for technology development and transfer	1+1
EXT 510	Gender sensitization for development	2+1
EXT 511	Perspectives of distance education	2+0
EXT 512	Market-led extension	2+0
EXT 591	Master's seminar	1+0

ANIMAL HUSBANDRY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
AAH-410	Poultry breeding	2+1
AAH-420	Poultry feeding	2+1
AAH-430	Egg and meat technology	1+1
AAH-440	Poultry farm management	2+1
AAH-450	Hatchery and brooding management	0+2
AAH-460	Broiler and layer management	0+2
AAH-470	Sheep goat and swine production	4+0
AAH-480	Sheep goat and swine breeding	4+0
AAH-490	Feed additives	2+0
AAH-510	Dairy cattle breeding	2+1
AAH-520	Dairy cattle feeding	2+1
AAH-530	Dairy farm management	2+1
AAH-540	Nutritional physiology of animals	3+0
AAH-550	Speciation and Evolution as Applied to Livestock Population	3+0
AAH-560	Livestock physiology	3+0
AAH-570	Application of selection theory	2+1
AAH-580	Diseases of dairy animals	2+0

AAH-590	Experimental techniques in animal nutrition	1+1
AAH-630	Population genetics	3+1
AAH-640	Quantitative genetics as applied to animal breeding - i	1+1
AAH-650	Quantitative genetics as applied to animal breeding - ii	1+1
AAH-660	Non-ruminant nutrition	2+1
AAH-670	Feed stuff evaluation	0+2
AAH-680	Ruminant nutrition	3+1
AAH-710	Advances in dairy animal production	3+0
AAH-720	Commercial dairy herd management	2+1
AAH-730	Feed and Fodder Technology	2+1
AAH-740	Energy nutrition	2+0
AAH-750	Protein nutrition	2+0
AAH-760	Vitamin nutrition	2+0
AAH-770	Mineral nutrition	2+0
AAH-780	Advanced animal breeding	2+1

ENTOMOLOGY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
ENT 501*	Insect morphology	1+1
ENT 502*	Insect anatomy, physiology and nutrition	2+1
ENT 503	Principles of taxonomy	2+0
ENT 504*	Classification of insects	2+1
ENT 505*	Insect ecology	1+1
ENT 506	Insect pathology	1+1
ENT 507*	Biological control of crop pests and weeds	1+1
ENT 508*	Toxicology of insecticides	2+1
ENT 509	Plant resistance to insects	1+1
ENT 510*	Principles of integrated pest management	1+1
ENT 511*#	Pests of field crops	1+1
ENT 512*#	Pests of horticultural and plantation crops	1+1
ENT 513	Storage entomology	1+1
ENT 514	Insect vectors of plant viruses and other pathogens	1+1
ENT 515	General acarology	1+1
ENT 516	Soil arthropods and their management	1+1
ENT 517	Vertebrate pest management	1+1
ENT 518*	Techniques in plant protection	0+1
ENT 519	Commercial entomology	1+1
ENT 520	Plant quarantine	2+0
ENT 591	Master's seminar	1+0
ENT 599	Master's research	20
ENT 601	Advanced insect systematics	1+2

ENT 602	Immature stages of insects	1+1
ENT 603	Advanced insect physiology	2+0
ENT 604	Advanced insect ecology	1+1
ENT 605	Insect behaviour	1+1
ENT 606	Recent trends in biological control	1+1
ENT 607	Advanced insecticide toxicology	2+1
ENT 608	Advanced host plant resistance	1+1
ENT 609	Advanced acarology	1+1
ENT 610	Agricultural ornithology	1+1
ENT 611**	Molecular approaches in entomological research	1+1
ENT 612**	Advanced integrated pest management	2+0
ENT 613/		
PL PATH 606\$ Plant biosecurity and biosafety		2+0
ENT 691	DOCTORAL SEMINAR I	1+0
ENT 692	DOCTORAL SEMINAR II	1+0
ENT 699	DOCTORAL RESEARCH	45
*Compulsory for Master's programme; ** Compulsory for Ph.D. programme		

#One out of 511 or 512 is compulsory; \$ Cross-listed with Plant Pathology

GENETICS AND PLANT BREEDING Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
GP 501*	Principles of genetics	3 (2 + 1)
GP 502*	Principles of cytogenetics	3 (2 + 1)
GP 503*	Principles of plant breeding	3 (2 + 1)
GP 504*	Principles of quantitative genetics	3 (2 + 1)
GP 505	Mutagenesis and mutation breeding	3 (2 + 1)
GP 506	Population genetics	2 (1 + 1)
GP 507*	Heterosis breeding	2 (1 + 1)
GP 508*	Cell biology and molecular genetics	3 (2 + 1)
GP 509*	Biotechnology for crop improvement	3 (2 + 1)
GP 510	Breeding for biotic and abiotic stress resistance	3 (2 + 1)
GP 511	Breeding cereals, forages and sugarcane	3 (2 + 1)
GP 512	Breeding legumes, oilseeds and fibre crops	3 (2 + 1)
GP 513	Breeding for quality traits	2 (1 + 1)
GP 514	Gene regulation and expression	2 (2 + 0)
GP 515	Maintenance breeding, concepts of variety release	2 (1 + 1)
	And seed production	
GP 516	Germplasm collection, exchange and quarantine	3 (2 + 1)

GP 517	Database management, evaluation and utilization of pgr	3 (2 + 1)
GP 591	Master's seminar	1 (1 + 0)
GP 599	Master's research	20
GP 601	Plant genetics resources and pre-breeding	2 (2 + 0)
GP 602	Advanced biometrical and quantitative genetics	3 (2 + 1)
GP 603**	Genomics in plant breeding	3 (2 + 1)
GP 604**	Molecular and chromosomal manipulations for Crop breeding	2 (2 + 0)
GP 605**	Advanced plant breeding systems	2 (2 + 0)
GP 606	Crop-evolution	3 (2 + 1)
GP 607	Breeding designer crops	2 (1 + 1)
GP 608	Advances in breeding of major filed crops	3 (3 + 0)
GP 609	Microbial genetics	3 (2 + 1)
GP 610**	In situ and ex situ conservation of germplasm	3 (2 + 1)
GP 691	Doctoral seminar I	1 (1 + 0)
GP 692	Doctoral seminar II	1 (1 + 0)
GP 699	DOCTORAL RESEARCH	45

Note : *Compulsory for Master's Programme; ** Compulsory for Ph.D. Programme

HORTICULTURE
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
APH-503	Systematic horticulture	2+1
APH-511	Plant propagation and nursery management	2+1
APH-513	Orchard management	2+1
APH-515	Advance pomology	2+1
APH-516	Advance olericulture	2+1
APH-521	Advance floriculture	2+1
APH-531	Medicinal and aromatic plant	2+1
APH-711	Nutrition of horticultural crops	3+1
APH-731	Post harvest physiology of horticultural crops	2+1
APH- 733	Research methods in horticulture	0+2
EXT 599	Master's research	20
EXT 601**	Advances in agricultural extension	2+1

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EXT 602**	Advanced design and techniques in social science research	2+1
EXT 603**	Advances in training technology	2+1
EXT 604**	Organizational development	2+1
EXT 605**	Advanced instructional technology	2+1
EXT 606	Theory construction in social sciences	2+0
EXT 607	Advanced management techniques	2+1
EXT 608	Media management	2+1
EXT 609	Transfer of technology in agriculture	2+1
EXT 691	Doctoral seminar I	1+0
EXT 692	Doctoral seminar II	1+0
EXT 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme; ** Compulsory for Doctoral programme

The following Basic Supporting courses (5 credits) are recommended for M. Sc. / Ph. D. programmes
M. Sc.

STAT	STATISTICAL METHODS FOR SOCIAL SCIENCES	2+1
STAT	NON-PARAMETRICS	2+0
Ph. D.		
STAT	STATISTICS	2+1
STAT	COMPUTER APPLICATION	1+1



PLANT PATHOLOGY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
PL PATH 501*	Mycology	2+1
PL PATH 502*	Plant virology	2+1
PL PATH 503*	Plant bacteriology	2+1
PL PATH 504*	Principles of plant pathology	3+0
PL PATH 505*	Detection and diagnosis of plant diseases	0+2
PL PATH 506	Principles of plant disease management	2+1
PL PATH 507	Diseases of field and medicinal crops	2+1
PL PATH 508	Diseases of fruits, plantation and ornamental crops	2+1
PL PATH 509	Diseases of vegetable and spices crops	2+1
PL PATH 510	Seed health technology	2+1
PL PATH 511	Chemicals in plant disease management	2+1
PL PATH 512	Ecology of soil-borne plant pathogens	2+1
PL PATH 513	Disease resistance in plants	2+0
PL PATH 514/ ENT 514\$	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1
PL PATH 515	Biological control of plant diseases	2+1
PL PATH 516	Integrated disease management	2+1
PL PATH 517	Mushroom production technology	2+1
PL PATH 518	Epidemiology and forecasting of plant diseases	2+1
PL PATH 519 PL PATH 520/ ENT 520\$	Post harvest diseases Plant quarantine	2+1 2+0
PL PATH 591	Master's seminar	1+0
PL PATH 599	Master's research	20
PL PATH 601	Advanced mycology	2+1
PL PATH 602	Advanced virology	2+1



PL PATH 603	Advanced bacteriology	2+1
PL PATH 604**	Molecular basis of host-pathogen interaction	2+1
PL PATH 605	Principles and procedures of certification	1+0
PL PATH 606	Plant biosecurity and biosafety	2+0
PL PATH 691	Doctoral seminar I	1+0
PL PATH 692	Doctoral seminar II	1+0
PL PATH 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme; ** Compulsory for Ph. D. programme; § Cross-listed with Entomology



REGISTRAR
S.V.B.P.U.A.&T., MEERUT

SOIL SCIENCE
Course Structure – at a Glance

CODE CREDITS	COURSE TITLE	
SOILS 501*	SOIL PHYSICS	2+1
SOILS 502*	Soil fertility and fertilizer use	3+1
SOILS 503*	SOIL CHEMISTRY	2+1
SOILS 504*	Soil mineralogy, genesis, classification and survey	2+1
SOILS 505	Soil erosion and conservation	2+1
SOILS 506*	Soil biology and biochemistry	2+1
SOILS 507	Geomorphology and geochemistry	2+0
SOILS 508	radioisotopes in soil and plant studies	1+1
SOILS 509	Soil,water and air pollution	2+1
SOILS 510	Remote sensing and gis techniques for soil and crop studies	2+1
SOILS 511	Analytical techniques and instrumental methods in Soil and plant analysis	0+2
SOILS 512	System approaches in soil and crop studies	2+1
SOILS 513	Management of problematic soils and waters	2+1
SOILS 514	Fertilizer technology	1+0
SOILS 515	Land degradation and restoration	1+0
SOILS 591	Master's seminar	1+0
SOILS 599	MASTER'S RESEARCH	20
SOILS 601	Advances in soil physics	2+0
SOILS 602	Advances in soil fertility	2+0
SOILS 603	Physical chemistry of soils	2+0
SOILS 604	Soil genesis and micropedology	2+0
SOILS 605	Biochemistry of soil organic matter	2+0
SOILS 606	Land use planning and watershed management	2+0
SOILS 691	Doctoral seminar I	1+0
SOILS 692	DOCTORAL SEMINAR II	1+0
SOILS 699	DOCTORAL RESEARCH	45

COLLEGE OF BIOTECHNOLOGY

SYLLABUS - II

PG (M.Tech/M.Sc)/ Ph.D

(Plant Molecular Biology
& Biotechnology)



SARDAR VALLABH BHAI PATEL UNIVERSITY OF
AGRICULTURE AND TECHNOLOGY,
MEERUT- 250 110

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S.V.B.P.U.A.&T., MEERUT

Syllabus I: 2010-11 to 2019-20.

Syllabus II: 2020-21. onwards

Print: July-2022

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College of Biotechnology
Course Structure- PG/ Ph.D. Program in

**PLANT MOLECULAR BIOLOGY AND
BIOTECHNOLOGY**

Code	Course Title	Credits	Pages
BTF 501	Principles of Biotechnology**	2+1	07
BTM 502	Fundamentals of Molecular Biology**	3+0	08
BTC 503	Molecular Cell Biology**	3+0	08
BTF 504	Plant Tissue Culture & Genetic Transformation	1+2	09
BTA 505	Techniques In Molecular Biology I**	0+3	10
BTO 506	Microbial/ Industrial Biotechnology	2+1	10
BTF 507	Molecular Breeding	2+0	11
BTR 508	Genomics & Proteomics	2+0	12
BTA 509	Techniques In Molecular Biology II	0+3	13
BTO 510	Biosafety, IPR and Bioethics*	2+0	13
BTI 511	Animal Biotechnology*	3+0	14
BTI 512	Immunology and Molecular Diagnostics*	2+1	15
BTB 513	Nano-Biotechnology*	3+0	16
BTM 551	Principles of Genetics*	2+1	17
BTB 552	Basic Biochemistry*	2+1	17
BAS 553	Biostatistics and Computers*, **	2+1	18
BTP 554	Principles of Microbiology*	2+1	19
BTI 555	Introduction to Bioinformatics	2+1	20
BTC 556	Environmental Biotechnology	3+0	20
BTS 591	Master's Seminar	1+0	-
BTS 599	Master's Research	20	-
BTM 601	Advances in Plant Molecular Biology	3+0	21
BTM 602	Advances in Genetic Engineering	3+0	22
BTP 603	Advances in Microbial Biotechnology	3+0	22
BTF 604	Advances in Crop Biotechnology	3+0	23
BTR 605	Advances in Functional Genomics and Proteomics	2+0	23
BTO 606	Commercial Plant Tissue Culture	2+0	24
BTI 607	Advances in Animal Biotechnology	2+0	24
BTS 691	Doctoral Seminar I	1+0	-
BTS 692	Doctoral Seminar II	1+0	-
BTS 699	Doctoral Research	45	-

*May be taken as minor/ supporting course (07 course: 22 credit), **Compulsory for M.Sc./M.Tech. Program (05 course: 15 credit)

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ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600-series to Doctoral level.
- A Ph.D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's program.
- Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Minimum Credit Requirements

S.	Subject	Master's Program	Doctoral Program
1.	Major	20	15
2.	Minor	09	08
3.	Supporting	05	05
4.	Seminar	01	02
5.	Research	20	45
6.	Total Credits	55	75
7.	Compulsory Non Credit Courses	PGS 501- PGS 506	

Major subject: The subject (department) in which the students takes admission

Minor subject: The subject closely related to students major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology or Nematology).

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501- PGS 506) are of general nature and are compulsory for Master's program. Ph. D. students may be exempted from these courses if already studied during Master's degree.

CODE	COURSE TITLE	CREDITS
PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skills	0+1
PGS 503	Intellectual Property and Its Management in Agriculture	1+0
PGS 504	Basic Concepts in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programs	1+0
PGS 506	Disaster Management	1+0



List of Course
M.Sc/ M.Tech. (Pl. Mol. Biol. & Biotech.)

M-Tech. (I Sem: PMBB New)

S.	Type of Course	Course Code	Course	Credit
1	Major/ Compulsory	BTF- 501	Principles of Biotechnology**	2+1
2	Major/ Compulsory	BTM- 502	Fundamentals of Molecular Biology**	3+0
3	Major/ Compulsory	BTC- 503	Molecular Cell Biology**	3+0
4	Major/ Supporting	BTI- 555	Introduction to Bioinformatics	2+1
5	Minor/ Supporting	BTM- 551	Principles of Genetics*	2+1
6	Major/ Supporting	BTF-504	Plant Tissue Culture & Genetic Transformation	1+2
7.	Minor/ Supporting	BTP- 554	Principles of Microbiology*	2+1
8.	Non credit	PGS- 501-506	Compulsory Non Credit Courses (06 PGS courses)	

*

Major 20 credit (Major/ compulsory, Major/ supporting), Minor 09 credit, Supporting 05 credit

M-Tech. (II Sem: PMBB New)

S.	Type of Course	Code	Course Name	Credit
1	Major/ Compulsory	BTA-505	Techniques In Molecular Biology I**	0+3
2	Major/ Compulsory	BAS 553	Biostatistics and Computers*, **	2+1
3	Seminar	BTS 591	Master's Seminar	1+0
4	Major/ Supporting	BTM 507	Molecular Breeding	2+0
5	Major/ Supporting	BTC 556	Environmental Biotechnology	3+0
6	Minor/ Supporting	BTB-522	Basic Biochemistry*	2+1
7	Minor/ Supporting	BTI- 512	Immunology and Molecular Diagnostics*	2+1
8	PGS 501-506	Compulsory Non Credit Courses (06 PGS courses)		

* Major 20 credit (Major/ compulsory, Major/ supporting), Minor 09 credit, Supporting 05 credit

M-Tech. (III Sem: PMBB New)

S.	Type of Course	Course Code	Course	Credit
1.	Major/ Supporting	BTR- 508	Genomics & Proteomics	2+0
2.	Major/ Supporting	BTO- 506	Microbial/ Industrial Biotechnology	2+1
3.	Minor/ Supporting	BTI- 511	Animal Biotechnology*	3+0
4.	Minor/ Supporting	BTB- 513	Nano-Biotechnology*	3+0
5.	Minor/ Supporting	BTO- 510	Biosafety, IPR and Bioethics*	2+0
6.	PGS 501-506	Compulsory Non Credit Courses (06 PGS courses)		

* Major 20 credit (Major/ compulsory, Major/ supporting), Minor 09 credit, Supporting 05 credit

List of Course
Ph.D. (Pl. Mol. Biol. & Biotech.)

Ph.D. (I Sem: PMBB New)

S.	Type of Course	Course Code	Course	Credit
1.	Major/ Supporting	BTM 601	Advances in Plant Molecular Biology	3+0
2.	Major/ Supporting	BTP 603	Advances in Microbial Biotechnology	3+0
3.	Major/ Supporting	BTI 607	Advances in Animal Biotechnology	2+0
4.	Seminar	BTS 692	Doctoral Seminar I	1+0
5.	Major/ Supporting	BTA 509	Techniques In Molecular Biology II	0+3
6.	Non credit	PGS 501-506	Compulsory Non Credit Courses (06 PGS courses)	

* A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's program. Non Credit courses must be taken if not studied during PG.

* Major 15 credit (Major/ compulsory, Major/ supporting), Minor 08 credit, Supporting 05 credit.

Ph.D. (II Sem: PMBB New)

S.	Type of Course	Code	Course Name	Credit
1.	Major/ Supporting	BTM 602	Advances in Genetic Engineering	3+0
2.	Major/ Supporting	BTF 604	Advances in Crop Biotechnology	3+0
3.	Major/ Supporting	BTR 605	Advances in Functional Genomics and Proteomics	2+0
4.	Major/ Supporting	BTO 606	Commercial Plant Tissue Culture	2+0
5.	Seminar	BTS 691	Doctoral Seminar II	1+0
6.	PGS 501-506	Compulsory Non Credit Courses (06 PGS courses)		

* A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's program. Non Credit courses must be taken if not studied during PG

* Major 15 credit (Major/ compulsory, Major/ supporting), Minor 08 credit, Supporting 05 credit

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PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Contents

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
- A list of journals pertaining to the discipline is provided at the end, which may be useful as study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

BTF 501 PRINCIPLES OF BIOTECHNOLOGY 2+1

Objective

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

Theory

UNIT I

History, scope and importance; DNA structure, function and metabolism. UNIT II

DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications.

UNIT III

Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics.

UNIT IV

General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Practical

- i. Isolation of genomic and plasmid DNA
- ii. Gel electrophoresis techniques
- iii. Restriction enzyme digestion, ligation, transformation and screening of transformants
- iv. PCR and molecular marker analysis
- v. Plant tissue culture: media preparation, cell and explant culture, regeneration and transformation.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. *Biotechnology – a Laboratory Course*. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima Pub.

Brown TA. *Gene Cloning and DNA Analysis*. 5th Ed. Blackwell Publishing.

Dale JW & von Schantz M. 2002. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publications.

Sambrook J, Fritsch T & Maniatis T. 2001. *Molecular Cloning – a Laboratory Manual*. 2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. *Biotechnology Expanding Horiozon*. Kalyani Publishers.

BTM 502 FUNDAMENTALS OF MOLECULAR BIOLOGY 3+0

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT I

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

UNIT II

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

UNIT III

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

UNIT IV

Translation and post-translational modifications; Operon concept; Attenuation of *trp* operon; important features of gene regulation in eukaryotes.

Suggested Readings

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publishers.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. W.H. Freeman & Co. Primrose SB.

2001. *Molecular Biotechnology*. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008.

Molecular Biology of the Gene. 6th Ed. Pearson Education International.

BTC 503 MOLECULAR CELL BIOLOGY 3+0

Objective

To familiarize the students with the cell biology at molecular level.

Theory

UNIT I

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions.

UNIT II

Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc. UNIT III

Organelar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements.

UNIT IV

Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

Suggested Readings



Gupta PK. 2003. *Cell and Molecular Biology*. 2nd Ed. Rastogi Publ. Lodish H. 2003. *Molecular Cell Biology*. 5th Ed. W.H. Freeman & Co. Primrose SB. 2001. *Molecular Biotechnology*. Panima.

BTF 504 PLANT TISSUE CULTURE AND GENETIC 1+2 TRANSFORMATION

Objective

To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

UNIT I

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration; Molecular basis of plant organ differentiation.

UNIT II

Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

UNIT III

Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc.

UNIT IV

Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

- i. Laboratory set-up.
- ii. Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
- iii. Anther and pollen culture.
- iv. Embryo rescue.
- v. Suspension cultures and production of secondary metabolites.
- vi. Protoplast isolation, culture and fusion.
- vii. Gene cloning and vector construction
- viii. Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Suggested Readings

Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons. Dixon RA. 2003. *Plant Cell Culture*. IRL Press.

George EF, Hall MA & De Klerk GJ. 2008. *Plant Propagation by Tissue Culture*. Agritech Publ. Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publ.

Herman EB. 2005-08. *Media and Techniques for Growth, Regeneration*

and Storage. Agritech Publ. Pena L. 2004. *Transgenic Plants: Methods and Protocols*. Humana Press.

Pierik RLM. 1997. *In vitro Culture of Higher Plants*. Kluwer. Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.

BTA 505 TECHNIQUES IN MOLECULAR BIOLOGY-I 0+3

Objective

To provide hands on training on basic molecular biology techniques.

Practical

UNIT I

Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography).

UNIT II

Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA and analysis.

UNIT III

Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR.

UNIT IV

Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. John Wiley.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. ColdSpring Harbour Laboratory Press.

BTO 506 MICROBIAL/ INDUSTRIAL BIOTECHNOLOGY 2+1

Objective

To familiarize about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.

Theory

UNIT I

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II
Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry.

UNIT III

Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bioaugmentation with production of vitamin C as a case study; Bioreactors, their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV



Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bioremediation of soil; Production of eco-friendly agricultural chemicals, biopesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

Practical

- i. Isolation of industrially important microorganisms, their maintenance and improvement.
- ii. Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery.
- iii. Study of bio-reactors and their operations.
- iv. Production of biofertilizers.
- v. Experiments on microbial fermentation process, harvesting purification and recovery of endproducts.
- vi. Immobilization of cells and enzymes, studies on its kinetic behavior, growth analysis and biomass estimation.
- vii. Determination mass transfer co-efficients.

Suggested Readings

Huffnagle GB & Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific. Primrose SB. 2001. *Molecular Biotechnology*. Panima.

BTF 507 MOLECULAR BREEDING 2+0

Objective

To familiarize the students about the use of molecular biology tools in plant breeding.

Theory

UNIT I

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

UNIT II

Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits.

UNIT III

QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

UNIT IV

Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding; MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07. *Genome Mapping and Molecular Breeding in Plants*. Vols. I-VII. Springer.

Newbury HJ. 2003. *Plant Molecular Breeding*. Blackwell Publ.

Weising K, Nybom H, Wolff K & Kahl G. 2005. *DNA Fingerprinting in Plants: Principles, Methods and Applications*. Taylor & Francis.

BTR 508 GENOMICS AND PROTEOMICS 2+0

Objective

To familiarize the students with recent tools used for genome analysis and their applications.

Theory

UNIT I

Structural genomics: Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation; Comparative genomics, etc.

UNIT II

Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Metabolomics and ionomics for elucidating metabolic pathways, etc.

UNIT III

Proteomics - Protein structure, function and purification; Introduction to basic proteomics technology; Bioinformatics in proteomics; Proteome analysis, etc.

UNIT IV

Applications of genomics and proteomics in agriculture, human health and industry.

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. JohnWiley & Sons.

Brown TA. 2007. *Genome III*. Garland Science Publ.

Campbell AM & Heyer L. 2004. *Discovery Genomics, Proteomics and Bioinformatics*. PearsonEducation.

Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.

Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.

Kamp RM. 2004. *Methods in Proteome and Protein Analysis*. Springer.

Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell. Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley CVH.

BTA 509 TECHNIQUES IN MOLECULAR BIOLOGY-II 0+3

Objective

To provide hands on training on various molecular techniques used in molecular breeding and genomics.

Practical

UNIT I

Construction of gene libraries; Synthesis and cloning of cDNA and RTPCR analysis; Real time PCR and interpretation of data.

UNIT II

Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers (linkage map, QTL analysis etc); SNP identification and analysis; Microarray studies and use of relevant software.

UNIT III

Proteomics (2D gels, mass spectrometry, etc.); RNAi (right from designing of construct to the phenotyping of the plant); Yeast 1 and 2-hybrid interaction.

UNIT IV

Generation and screening of mutants; Transposon mediated mutagenesis.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Caldwell G, Williams SN & Caldwell K. 2006. *Integrated Genomics: A Discovery-Based Laboratory Course*. John Wiley.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. ColdSpring Harbour Laboratory Press.

BTO 510 BIOSAFETY, IPR AND BIOETHICS 2+0

Objective

To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.

Theory

UNIT I

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT II

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

UNIT III

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products. **Suggested Readings**

Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.

<http://patentoffice.nic.in>

www.wipo.org www.dbtindia.nic.in

www.dbtbiosafety.nic.in

BTI 511 ANIMAL BIOTECHNOLOGY 3+0

Objective

Intended to provide an overview and current developments in different areas of animal biotechnology.

Theory

UNIT I

Structure of animal cell; History of animal cell culture; Cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II

Introduction to immune system, cellular and hormonal immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, antigen-antibody based diagnostic assays including radioimmunoassays and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT III

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-splitting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

UNIT IV

Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes,

SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Transgenic animal production and application in expression of therapeutic proteins. Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Suggested Readings

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI. Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WHFreeman.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.

Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

BTI IMMUNOLOGY AND MOLECULAR DIAGNOSTICS 2+1

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin chemistry, structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT II

Antibody diversity; antigens, haptens, antigens- antibody interactions; immuno-regulation and tolerance; Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques.

UNIT III

Immunological application in plant science, monoclonal antibodies and their uses, molecular diagnostics. Introduction to the basic principles of molecular technology and techniques used in pathogen detection, Principles of ELISA and its applications in viral detection.

UNIT IV

Basics and procedures of PCR, Real time PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

- i. Preparation of buffers and reagents.
- ii. Immunoblotting, immunoelectrophoresis and fluorescent antibody test.
- iii. Enzyme immunoassays including ELISA western blotting.
- iv. Extraction and identification of DNA/RNA of pathogenic organisms.
- v. Restriction hybridoma technique and production of monoclonal antibodies.
- vi. Immunogenic proteins, expression and immunogenicity studies, purification of immunogenic protein and immunization of laboratory animals.

Suggested Readings

- Bloom BR & Lambert P-H. 2002. *The Vaccine Book*. Academic Press.
- Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press. Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby's Immunology*. WH Freeman.
- Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.
- Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press. Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology*. Elsevier.
- Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience. Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.
- Spinger TA, 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

BTB 513 NANO-BIOTECHNOLOGY 3+0

Objective

Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT I

Introduction to Biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT II

Cellular engineering: signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

UNIT III

Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems, UNIT IV

Preparation and characterization of nanoparticles; Nanoparticulate carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

Suggested Readings

- Nalwa HS. 2005. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*. American Scientific Publ.

Niemeyer CM & Mirkin CA. 2005. *Nanobiotechnology*. Wiley Interscience.

BTM 551 PRINCIPLES OF GENETICS 2+1

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problemsolving skills from classical to molecular genetics.

Theory

UNIT I

Early concepts of inheritance; Discussion on Mendel's paper; Sex determination, differentiation and sex-linkage, Sex-influenced and sexlimited traits; Linkage, recombination and genetic mapping in eukaryotes, Somatic cell genetics.

UNIT II

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes; Mutations and mutagenic agents.

UNIT III

Genetic code and protein biosynthesis; Gene regulation, Genes in development; Extra chromosomal inheritance, Male sterility and incompatibility; Recombination in bacteria, fungi and viruses, tetrad analysis.

UNIT IV

Inheritance of quantitative traits; Concepts in population genetics; Genes and behavior; Genetics and evolution; Recombinant DNA technology; Genetic fine structure analysis, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families; An overview of some recent discoveries in the field of genetics.

Practical

- i. Laboratory exercises in probability and chi-square.
- ii. Demonstration of genetic principles using laboratory organisms.
- iii. Chromosome mapping using three point test cross.
- iv. Tetrad analysis.
- v. Induction and detection of mutations through genetic tests.
- vi. Pedigree analysis in humans.
- vii. Numerical problems on Hardy Weinberg Equilibrium, Quantitative inheritance and Molecular genetics.

Suggested Readings

Klug WS & Cummings MR. 2003 *Concepts of Genetics*. Peterson Education. Lewin B.

2008. *Genes IX*. Jones & Bartlett Publ.

Russell PJ. 1998. *Genetics*. The Benjamin/Cummings Publ. Co. Strickberger

MW. 1990. *Genetics*. Collier MacMillan.

Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.

Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

BTB 552 BASIC BIOCHEMISTRY 2+1

Objective

To provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.

Theory

UNIT I



Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation; recombinant DNA technology, Nutritional aspects of carbohydrates, lipids, proteins and minerals.

Practical

- i. Preparation of standard and buffer solutions.
- ii. Extraction and estimation of sugars and amino acids.
- iii. Estimation of proteins by Lowry's method.
- iv. Estimation of DNA and RNA by Diphenylamine and orcinol methods.
- v. Estimation of ascorbic acid.
- vi. Separation of biomolecules by TLC and paper chromatography

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley. Metzler DE. *Biochemistry*. Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger's Principles of Biochemistry*. MacMillan. Voet D & Voet JG. *Biochemistry*. 3rd Ed. Wiley International.

BAS 553 BIOSTATISTICS AND COMPUTERS 2+1

Objective

This is the special course for M.Sc. students of Biotechnology. They are exposed to various statistical methods to analyze their experimental data.

Theory

UNIT I

Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis.

UNIT II

Concept of probability and probability laws, mathematical expectation, moments, moment generating function; Standard probability distributions- Binomial, Poisson and Normal distributions.

UNIT III

Tests of significance based on Z, χ^2 , t and F statistics; Correlation and regression, curve fitting by least squares methods.

UNIT IV

Basic principles, organization and operational aspects of computers, operating systems. Introduction to MS-Office, MS-Word, MS-Excel. Statistical Data analysis based on above topic through MS-Excel.

Practical

- i. Data analysis using probability, test of significance
- ii. Correlation and regression analysis
- iii. Usage of MS-Windows
- iv. Exercises on test processing, spreadsheet and DBMS

P

v. SPSS

Suggested Readings

Agarwal BL. 2003. *Basic Statistics*. New Age.

Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.

Dutta NK. 2002. *Fundamentals of Bio-Statistics*. Kanishka Publ.

BTP 554 PRINCIPLES OF MICROBIOLOGY 2+1

Objective

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

Theory

UNIT I

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

Practical

- i. Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).
- ii. Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria.
- iii. Use of selective media, antibiotic resistance and isolation of antibiotic producing microorganisms.
- iv. Morphological, physiological and biochemical characterization of bacteria.

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books. Pelczar ML Jr.

1997. *Microbiology*. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan. Tauro P,

Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

BTI 555 INTRODUCTION TO BIOINFORMATICS 2+1

Objective


To impart an introductory knowledge about the subject of bioinformatics to the students studying any discipline of science.

Theory

UNIT I

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genbank, DDBJ. Specialized genomic resources.

UNIT II


REGISTRAR
S.V.B.P.U.A.&T., MEEBUI

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT III

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV

Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

- i. Usage of NCBI resources
- ii. Retrieval of sequence/structure from databases
- iii. Visualization of structures
- iv. Docking of ligand receptors
- v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education. Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

BTC 556 ENVIRONMENTAL BIOTECHNOLOGY 3+0

Objective

To apprise the students about the role of biotechnology in environment management for sustainable ecosystem and human welfare.

Theory

UNIT I

Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

UNIT II

Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents etc; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filtration, etc.

UNIT III

Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

UNIT IV

Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

Suggested Readings

Evans GM & Furlong JC. 2002. *Environmental Biotechnology: Theory and Application*. Wiley International.

Jordening H-J & Winter J. 2006. *Environmental Biotechnology: Concepts and Applications*. Wiley-VCH Verlag.

BTM 601 ADVANCES IN PLANT MOLECULAR BIOLOGY 3+0

Objective



To discuss the specialized topics and recent advances in the field of plant molecular biology.

Theory

UNIT I

Arabidopsis in molecular biology, Forward and Reverse Genetic Approaches, Transcriptional and post-transcriptional regulation of gene expression, isolation of promoters and other regulatory elements.

UNIT II

RNA interference, Transcriptional gene silencing, Transcript and protein analysis, use of transcript profiling to study biological systems.

UNIT III

Hormone regulatory pathways: Ethylene, Cytokinin, Auxin and ABA, SA and JA; ABC Model of Floral Development, Molecular basis of self incompatibility, Regulation of flowering: photoperiod, vernalization, circadian rhythms.

UNIT IV

Molecular biology of abiotic stress responses: Cold, high temperature, submergence, salinity and drought; Molecular Biology of plant-pathogen interactions, molecular biology of *Agrobacterium* Infection, Molecular biology of *Rhizobium* infection (molecular mechanisms in symbiosis), Programmed cell death in development and defense.

Suggested Readings

Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publ.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*. WH Freeman & Co. Watson JD,

Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008.

Molecular Biology of the Gene. 6th Ed. Pearson Education.

BTM 602 ADVANCES IN GENETIC ENGINEERING 3+0

Objective

To discuss the specialized topics and advances in field of genetic engineering and their application in plant improvement.

Theory

UNIT I

General overview of transgenic plants; Case studies: Genetic engineering of herbicide resistance, Transgenic plants resistant to insects/pests, Genetic engineering of abiotic stress tolerance, Engineering food crops for quality, Genetically engineered pollination control, Induction of male sterility in plants.

UNIT II

Molecular farming of plants for applications in veterinary and human medicine systems: Boosting heterologous protein production in transgenics, Rapid production of specific vaccines, High-yield production of therapeutic proteins in chloroplasts.

UNIT III

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement; Gene stacking; Pathway engineering; Marker-free transgenic development strategies; High throughput phenotyping of transgenic plants.

UNIT IV

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Suggested Readings

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons. Specific journals mentioned later.

BTP 603 ADVANCES IN MICROBIAL BIOTECHNOLOGY 3+0

Objective

To discuss specialized topics about industrially important microorganisms.

Theory

UNIT I

Fermentative metabolism and development of bioprocessing technology, processing and production of recombinant products; isolation, preservation and improvement of industrially important microorganisms.

UNIT II

Immobilization of enzymes and cells; Batch, plug flow and chemostate cultures; Computer simulations; Fed-batch and mixed cultures; Scale-up principles; Down stream processing etc.

UNIT III

Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms.

UNIT IV

Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Factors affecting delignification; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology.

Suggested Readings

Specific journals and published references.

BTF 604 ADVANCES IN CROP BIOTECHNOLOGY 3+0

Objective

To discuss specialized topics on the application of molecular tools in breeding of specific crops.

Theory

UNIT I

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement.

UNIT II

Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

UNIT III

Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker assisted selection of qualitative and quantitative traits.

UNIT IV

Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane etc.

Suggested Readings

Specific journals and published references.

BTR 605 ADVANCES IN FUNCTIONAL GENOMICS 2+0 AND PROTEOMICS

Objective

To discuss recent advances and applications of functional genomics and proteomics in agriculture, medicine and industry.

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Theory

UNIT I

Genome sequencing and functional genomics; Human, animal, plant, bacterial and yeast genome projects; genome annotation; *ab initio* gene discovery; functional annotation and gene family clusters; etc.

UNIT II

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling; SAGE; SNPs/variation; yeast-two hybrid screening; gene expression and transcript profiling; EST contigs; EcoTILLING; allele/gene mining; synteny and comparative genomics; Genome evolution, speciation and domestication etc.

UNIT III

Proteomics: protein annotation; protein separation and 2D PAGE; mass spectroscopy; protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

UNIT IV

Discussion on selected papers on functional genomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

BTO 606 COMMERCIAL PLANT TISSUE CULTURE 2+0

Objective

To discuss the commercial applications of plant tissue culture in agriculture, medicine and industry.

Theory

UNIT I

Micropropagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNIT II

Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNIT III

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethic issues; management and commercialization.

UNIT IV

Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Suggested Readings

Specific journals and published references.

BTI 607 ADVANCES IN ANIMAL BIOTECHNOLOGY 2+0

Objective

Intended to provide cutting edge knowledge on advances in different areas of animal biotechnology.

Theory


REGISTRAR
S.V.B.P.U.A. & MEERUT

UNIT I

Advances in animal cell culture technology, suspension culture technology, advances in commercial scale productions of mammalian cells.

UNIT II

Advances in cell cloning and cell hybridization, advances in monoclonal antibody production technology, Advances in diagnostic technology, Computational vaccinology, reverse genetics based vaccines.

UNIT III

Advances in embryo manipulation, knock out and knock in technology, advances in animal cloning technology, stem cell technology, Advances in development of animal models for human diseases using transgenic animal technology.

UNIT IV

Advances in genetic basis for animal disease resistance, Molecular methods for animal forensics, Advances in animal genomics, proteomics,



PG/Ph.D

Plant Molecular Biology & Biotechnology

Duration (PG)	Two academic years (4 semesters)
Duration (Ph.D)	Three academic years (6 semesters)
Minimum Eligibility, Curriculum	http://www.svpuat.ac.in

/Structure & other details:

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: To equip students with fundamental concepts of core domain subjects of Biological systems, environment and biotechnology and learn how different biotechnological approaches are used around the world to manage various relevant issues in diverse areas of Plant biology.

PEO2: To encourage students for undertaking various latest and innovative research theme and ideas, which benefit society. The student will develop simulations to think as a biotechnological strategist and design an appropriate solution to diverse problems in areas of Agriculture, Health, Industry etc.

PEO3: To provide practical experience and exposure of working on diverse biotechnological problems.

Students will develop ethical practices and imbibe values for becoming Biotechnology professionals.

PEO4: To equip students with latest analytical tools and bioinformatics software, which help in analysis of the biological and environmental factors relevant to various segments of Plant biotechnology.

PROGRAMME OUTCOMES (POs)

PO1: Deeper understanding of Biotechnological Functions: Expertise in learning processes and functions that operates in Biological Organisms with focus on Plant Biotech related aspects.

PO2: Interpersonal Skill Development: Expertise in communication both spoken as well as written form.

PO3: Enhance creativity and developing Critical and Analytical Thinking Abilities: Critical thinking in academics, presentations, research and professional alliances relies heavily on one's ability to be creative.

PO4: Exposure for developing Entrepreneurship Acumen: Helps to prepare students for research/managerial roles and as entrepreneurs.

PO5: Develop skills to Identify problems, define objectives collect and analyse information, evaluate alternatives, and leverage technology to enable qualitative and quantitative methods to solve problems. Equips students to demonstrate the capabilities required to apply cross-functional knowledge and technologies in solving real-world biotechnological problems.

PO6: Appropriate techniques: Enables students to demonstrate use of appropriate techniques to effectively manage academic and research challenges in field of Biotechnology.

PO7: Practical exposure: Providing an opportunity for the students to gain practical exposure towards various sections of biotechnology, the workplace and make them industry ready.

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P08: Analytical and Decision Making qualities: Equip students with techniques of analyzing and interpretation of the research data which is used in Decision Making.



PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To inculcate students with the ability to analyze various functional issues affecting the biotechnological organization and acquiring conceptual clarity of various functional areas of Plant biotechnology.

PSO2: The students understand the ethical challenges and choices in a biotechnological unit setting and develop ability to evolve strategies for organizational benefits.

PSO3: To incorporate in students the benefits and ability to gain multidisciplinary knowledge through seminar reports, case study analysis, Research projects and industrial training and Organizational visits.

PSO4: Demonstrate ability to work in Groups and leadership in their career.

PSO5: To organize Workshops, Short Term Courses, Conferences, and seminars for students throughout the course for better understanding of the subject expertise, knowledge and skills required to the organization/ industry.

COURSE OUTCOMES (COs)

Subject	Subject Code	Course Outcomes
Principles of Biotechnology**	BTF 501	Familiarizes the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.
Fundamentals of Molecular Biology**	BTM 502	Imparts the students with the basic cellular processes at molecular level.
Molecular Cell Biology**	BTC 503	Develops understanding of the students on the cell biology at molecular level.
Plant Tissue Culture & Genetic Transformation	BTF 504	Familiarizes the students with hands on training on various techniques of plant tissue culture, genetic engineering and transformation.
Techniques In Molecular Biology I**	BTA 505	Provides hands on training on basic molecular biology techniques.
Microbial/ Industrial Biotechnology	BTO 506	Acquaints the students about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.
Molecular Breeding	BTF 507	Familiarizes the students about the use of molecular biology tools in plant breeding.
Genomics & Proteomics	BTR 508	Introduces the students with recent tools used for genome analysis and their applications.
Techniques In Molecular Biology II	BTA 509	Provides hands on training on various molecular techniques used in molecular breeding and genomics.
Biosafety, IPR and Bioethics*	BTO 510	Development of awareness about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.
Animal Biotechnology*	BTI 511	Provides an overview and current developments in different areas of animal biotechnology.

Immunology and Molecular Diagnostics*	BTI 512	Awareness about the application of various immunological and molecular diagnostic tools.
Nano-Biotechnology*	BTB 513	Develops understanding of the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.
Principles of Genetics*	BTM 551	Development of understanding about the basic concepts of genetics, students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.
Basic Biochemistry*	BTB 552	Provides elementary knowledge/overview of structure, functions and metabolism of biomolecules.
Biostatistics and Computers*, **	BAS 553	Exposure of students to various statistical methods to analyze their experimental data.
Principles of Microbiology*	BTP 554	Acquaints the students with history, classification and role of microbiology in agriculture, food and environment.
Introduction to Bioinformatics	BTI 555	Imparts an introductory knowledge about the subject of bioinformatics to the students studying any discipline of science.
Environmental Biotechnology	BTC 556	Apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.
Master's Seminar	BTS 591	1. Demonstrate use of appropriate methodologies and test the strength of their topic statement. 2. Shall be able to show insight on topic, appropriate signposting, and clarity of purpose. 3. Demonstrate problem-solving skills and apply theoretical knowledge.
Master's Research	BTS 599	Research topics provides practical skills and facilitate for appropriate research directions to the PG students.
Advances in Plant Molecular Biology	BTM 601	Understanding and discussions on the specialized topics and recent advances in the field of plant molecular biology.
Advances in Genetic Engineering	BTM 602	Imparts knowledge on specialized topics and advances in field of genetic engineering and their application in plant improvement.
Advances in Microbial Biotechnology	BTP 603	Apprise the students on specialized topics about industrially important microorganisms.
Advances in Crop Biotechnology	BTF 604	Knowledge on specialized topics on the application of molecular tools in breeding of specific crops.
Advances in Functional Genomics and Proteomics	BTR 605	It provides recent advances and applications of functional genomics and proteomics in

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		agriculture, medicine and industry.
Commercial Plant Tissue Culture	BTO 606	Enables to accomplish the commercial applications of plant tissue culture in agriculture, medicine and industry.
Advances in Animal Biotechnology	BTI 607	Provides cutting edge knowledge on advances in different areas of animal biotechnology.
Doctoral Seminar I	BTS 691	1. To develop understanding on selected topic. 2. Information collection and its organization into a presentation. 3. To develop Effective presentation and communication abilities.
Doctoral Seminar II	BTS 692	1. Demonstrate use of appropriate methodologies and test the strength of their selected topics. 2. Shall be able to show insight on topic, appropriate signposting, and clarity of purpose. 3. Demonstrate problem-solving skills and apply theoretical knowledge.
Doctoral Research	BTS 699	1. Carry out a substantial research-based project. 2. Analyze data and synthesize research findings. 3. Report research findings in written and verbal forms. 4. Use research findings to advance scientific theory and practice.

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