भाकृअनुप
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SIXTH
DEANS' COMMITTEE
REPORT

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

SIXTH DEANS' COMMITTEE REPORT

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DAIRY TECHNOLOGY

Course Curricula for Undergraduate Programme in Dairy Technology UG-Certificate (Dairy Technology) UG-Diploma (Dairy Technology) B. Tech. (Dairy Technology)

INTRODUCTION

The syllabus for undergraduate program in Dairy Technology has been restructured to fulfil the requirements of National Education Policy (NEP), which envisages to build strong foundation of theoretical understanding of the subject and give adequate hands on experience to the students to develop competence and confidence to successfully embark on their journey to professional life.

The restructured syllabus therefore has provision for skill enhancement modules and students will get opportunities to choose from a bouquet of offered modules to develop proficiency in practical aspects of the technology. Besides, there are opportunities for holistic improvement in their personality through Foundation course *(Deeksharambh)*. Students will also have liberty to choose limited number of online courses in areas such as art, humanities or modern technologies for broadening their vision.

The restructuring exercise for the common syllabus of the three identified programs viz., UG-Certificate (Dairy Technology), UG-Diploma (Dairy Technology) and B. Tech (Dairy Technology) has been carried out after consultations and incorporation of inputs from Deans' of Colleges offering UG courses. Many senior and young faculty members at different colleges involved in teaching these courses, alumni in the industry and other stakeholders have provided valuable inputs at various stages of the restructuring exercise.

HIGHLIGHTS

- The B. Tech. (Dairy Technology) program will be of 172 credit hours (physical) and 08 credit hours (online) spread over eight semesters.
- Adequate weightage has been given to skill development courses in the first two years, semesters I to IV. Students have been given flexibility and choice in selection of skill development courses from a bouquet of multiple 'SEC modules' offered in all the four semesters of the first two years.
- In the first year, after completing the course requirement of minimum 40 credits in both the semesters, there is compulsory provision of extra 10 credits in lieu of internship of 10 weeks duration through Industry placement/Industry exposure/ Hands-on-training with the Dairy/Food Industry in related domain to become eligible on exit for the award of UG Certificate in Dairy Technology in one of the three chosen areas.
- After completion of two years, an internship of 10 weeks is necessary for those exiting after two years to become eligible for the award of UG Diploma in Dairy Technology. Students will thus complete requirement of minimum 80 credits plus 10 weeks of Internship.
- These students are expected to acquire competency and confidence to not only become employable but also self motivated to start their own enterprise.
- More emphasis has been given to proper amalgamation of theory and practical to provide them in-depth knowledge of the B. Tech (Dairy Technology) syllabus.
- Students will also have the flexibility to complete these non-gradial elective courses of 08 credits spread over the entire four years of the UG Program. Students can select the online courses on varying topics of their interest ranging from advanced sciences, computing, data sciences, AI, machine learning to humanities. The course can be chosen from various online platforms available such as SWAYAM, edX, Coursera etc.
- In eighth semester of the degree program students will be offered Internship (Industrial training) of 20 credits. On successfully completing the four years degree requirement, the student will be awarded undergraduate degree B. Tech (Dairy Technology).

Entry and Exist Options

The entry and exit options for the UG program in Dairy Technology are shown in the Fig.1

- **Exit options after one and two years**

Dairy Technology

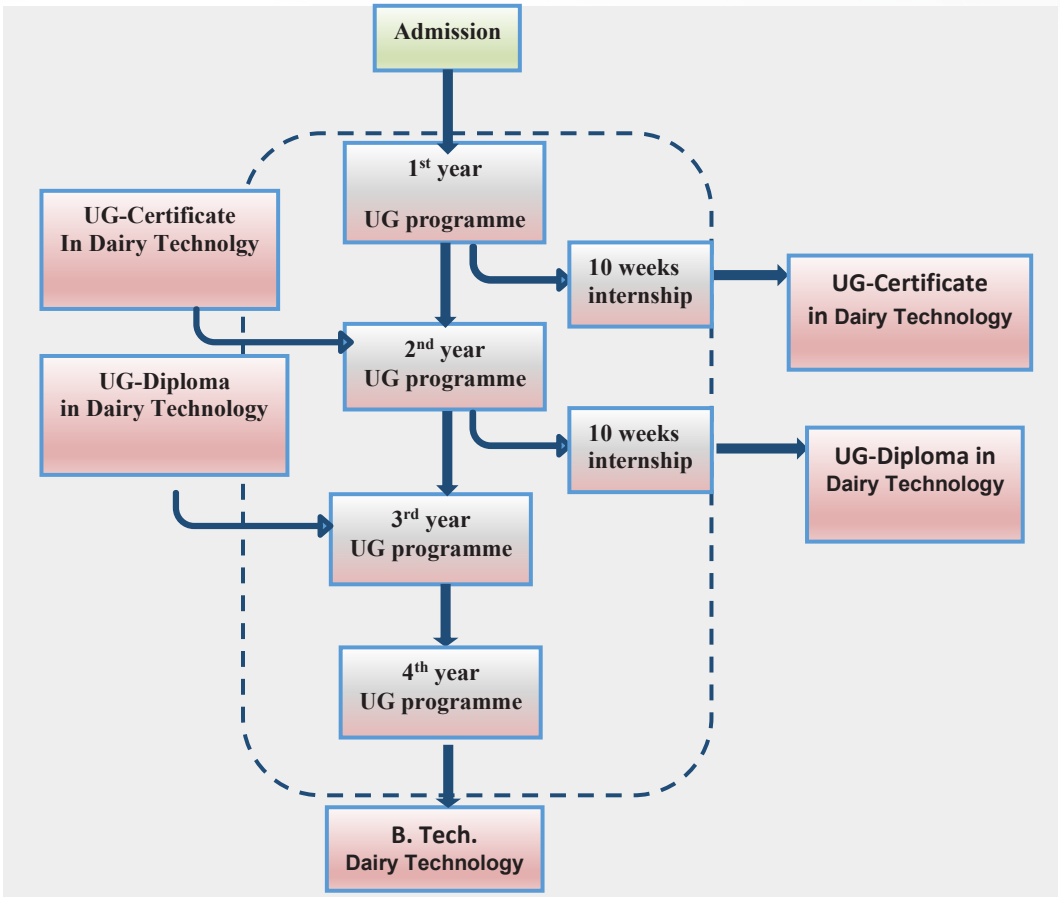

Fig.1 Entry and Exit options for the UG program in Dairy Technology

Exit options

1. **UG-Certificate (Dairy Technology)** (Exit after first year and completion of 10 weeks' internship)
2. **UG-Diploma (Dairy Technology)** (Exit after second year and completion of 10 weeks' internship)
3. **B.Tech. (Dairy Technology)** (On successful completion of four-year degree requirements)

UG- Certificate (Dairy Technology) in one of the following three areas- Exit after First Year and completion of 10 weeks' internship

- Dairy Products Processing
- Dairy Plant Maintenance
- Milk Quality Testing
- Admission mode–Common Entrance Test (National/ State/ University level) Eligibility: 10+2 Science with Mathematics as one of the subjects.

- The candidates having UG- Certificate (Dairy Technology) or UG- Diploma (Dairy Technology) will be allowed admission to the B. Tech (Dairy Technology) program in III semester or V semester, respectively.
- The students will register for a maximum of two modules of Skill Development Course/Skill for Employment and Entrepreneurship Development (SEC) during each semester in the first year. Thus, the name(s) of modules taken by the student will be reflected in the UG certificate award, such as UG-Certificate (Dairy Technology) in XXX (names of the modules).

ACADEMIC PROGRAMME

Semester-wise course distribution

S. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	Semester-I		
1.	*Deeksharambh* (Foundational two-week orientation course)	2 (0+2) NG	**22 (9+13) + 2 (Non-gradial)**
2.	Workshop Practice	2 (1+1)	
3.	Fluid Mechanics	2 (1+1)	
4.	Engineering Drawing	1 (0+1)	
5.	Fundamentals of Microbiology	2 (1+1)	
6.	Physical Chemistry of Milk	2 (1+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Communication Skills	2 (1+1)	
9.	Farming Based Livelihood System	3 (2+1)	
10.	NCC-I / NSS-I	1 (0+1)	
11.	****Skill Enhancement Course (SEC)- I	2 (0+2)	
12.	****Skill Enhancement Course (SEC)- II	2 (0+2)	
09 Credit for Core (Basic) Courses (2,3,4,5,6) 09 Credit for Common Courses: (7,8,9,10) 4 Credit for Skill Enhancement Course (SEC) (11&12)			
	Semester-II		
1.	Market Milk	4 (3+1)	**25 (13+12)**
2.	Heat & Mass Transfer	3 (2+1)	
3.	Basic Electrical Engineering	3 (2+1)	
4.	Microbiology of Fluid milk	2 (1+1)	
5.	Chemistry of Milk	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Personality Development	2 (1+1)	

S. No.	Course Title	Credit Hours	Total Credit hours
8.	NCC-II / NSS-II	1 (0+1)	
9.	****Skill Enhancement Course (SEC)-III	2 (0+2)	
10.	****Skill Enhancement Course (SEC)-IV	2 (0+2)	
15 Credit for Core (Basic) Courses (1, 2, 3, 4, 5) 6 Credit for Common Courses (6, 7, 8) 4 Credit for Skill Enhancement Course (SEC) (9 & 10)			
INT	Internship (10 weeks)	10 (0+10)*	**10 (0+10)***
Student taking various modules will get a Certificates with Nomenclature as follows-			
Nomenclature of Certificate			
Milk and Milk Products Processing			
Dairy Plant Maintenance			
Milk Quality Testing			
*Compulsory Internship for students exercising exit option (UG-Diploma) after I Year			
Second year			
Semester-III			
1.	Thermodynamics	3 (2+1)	**21 (11+10)**
2.	Traditional Indian Dairy Products	3 (2+1)	
3.	Dairy Engineering	3 (2+1)	
4.	Refrigeration & Air-conditioning	3 (2+1)	
5.	Starter Culture and Fermented Dairy Products	2 (1+1)	
6.	Physical Education, First Aid, Yoga Practices, and Meditation	2 (0+2)	
7.	Agriculture Marketing & Trade	3 (2+1)	
8.	****Skill Enhancement Course (SEC)-V	2 (0+2)	
14 Credit for Core (Basic) Courses (1,2,3,4,5) 5 Credits for Common Courses (6 & 7) 2 Credit for Skill Enhancement Course (SEC) (8)			
Semester-IV			
1.	Cheese Technology	5 (3+2)	**22 (12+10)**
2.	Fat Rich Dairy Products	3 (2+1)	
3.	Ice-cream & Frozen Deserts	3 (2+1)	
4.	Chemistry of Dairy Products	2 (1+1)	
5.	Microbiology of Dairy Products	2 (1+1)	
6.	ICT in Dairy Industry	2 (1+1)	
7.	Entrepreneurship Development and Business Management	3 (2+1)	
8.	****Skill Enhancement Course(SEC)-VI	2 (0+2)	
17 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6) 3 Credits for Common Course (7) 2 Credit for Skill Enhancement Course (SEC) (8)			

S. No.	Course Title	Credit Hours	Total Credit hours
INT	Internship (10 weeks)	10 (0+10)**	**10 (0+10)****
**Compulsory Internship for students exercising exit option (UG-Diploma) after I Year			
Third Year			
Semester-V			
1.	Condensed & Dried Milks	4 (3+1)	**22 (15+7)**
2.	Dairy By-products Technology	3 (2+1)	
3.	Quality and Safety Monitoring in Dairy Industry	3 (2+1)	
4.	Chemical Quality Assurance	2 (1+1)	
5.	Instrumentation and Process Control	3 (2+1)	
6.	Dairy Process Engineering	3 (2+1)	
7.	Operations Research	2 (1+1)	
8.	Economic Analysis	2 (2+0)	
Study tour*		**2 (0+2) NG**	**2 (0+2) NG**
22 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8) **2 credit (Non gradial) for Study tour (10-12 days during semester break)**			
Semester-VI			
1.	Dairy Plant Management and Pollution Control	2 (1+1)	**20 (12+8)**
2.	Strength of Materials & Dairy Machine Design	3 (2+1)	
3.	Financial Management & Cost Accounting	3 (2+1)	
4.	Food and Industrial Microbiology	2 (1+1)	
5.	Packaging of Dairy Products	2 (1+1)	
6.	Food Technology - I	3 (2+1)	
7.	Food Chemistry	3 (2+1)	
8.	Energy Conservation and Management	2 (1+1)	
20 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8)			
Fourth Year			
Semester-VII			
1.	Food Engineering	3 (2+1)	**20**
2.	Dairy Plant Design and Layout	2 (1+1)	
3.	Food Technology-II	3 (2+1)	
4.	Sensory Evaluation of Dairy Products	2 (1+1)	
5.	Biochemistry and Human Nutrition	2 (1+1)	
6.	Elective Courses	8***	
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses should be opted to complete total 20 credits)			

Semester-VIII			
1	In-plant Training	One Semester (0+20)	**20 (0+20)**
Online Courses			
1	Online Courses	**08**	**08**

****SEC-I, SEC-II, SEC-III, SEC-IV, SEC-V and SEC-VI to be selected from the list of the basket available under SEC-II module.

Department/Section-wise Course Breakup

S. No.	Course Title	Credit hours	Total
Foundational courses (two week)			
	Deeksharambh	0+2 (NG)*	2 (0+2)
Common Courses			
MDC	Farming Based Livelihood System	3 (2+1)	09
	Agriculture Marketing & Trade	3 (2+1)	
	Entrepreneurship Development and Business Management	3 (2+1)	
VAC	Agricultural Informatics and Artificial Intelligence	3 (2+1)	06
	Environmental Studies and Disaster Management	3 (2+1)	
AEC	Communication Skills	2 (1+1)	08
	NSS/ NCC –I	1 (0+1)	
	Personality Development	2 (1+1)	
	NSS/ NCC – II	1 (0+1)	
	Physical Education, First Aid and Yoga Practices	2 (0+2)	
Department/ Section			
	Study Tour	2 (0+2) NG*	02

• Non- Gradial

Dairy Technology

Course category	Course title	Credit Hours
Core Courses	Market milk	4 (3+1)
	Traditional Dairy Products	3 (2+1)
	Fat Rich Dairy Products	3 (2+1)
	Condensed and Dried Milks	4 (3+1)
	Cheese Technology	5 (3+2)
	Ice Cream and Frozen Desserts	3 (2+1)
	Dairy By Products Technology	3 (2+1)
	Packaging of Dairy Products	2 (1+1)

Course category	Course title	Credit Hours
	Sensory Evaluation of Dairy Products	2 (1+1)
	Dairy Plant Management and Pollution Control	2 (1+1)
	Food Technology I	3 (2+1)
	Food Technology II	3 (2+1)
SEC modules****	Operation of dairy evaporators and dryers	2 (0+2)
	Operation of liquid milk processing system	2 (0+2)
	Operation of ice cream freezers, ice candy making unit and their packaging	2 (0+2)
	Packaging of milk and milk products	2 (0+2)
	Technology of heat and acid coagulated milk products	2 (0+2)
	Canning and Sterilization systems for Dairy and Food Applications	2 (0+2)
	Extrusion Processing in Dairy and Food Industry	2 (0+2)
	Calibration of Dairy Equipments/Instrument	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Engineering

Course category	Course title	Credit Hours
Core Courses	Workshop Practice	2 (1+1)
	Fluid Mechanics	3(2+1)
	Engineering Drawing	1(0+1)
	Thermodynamics	3 (2+1)
	Heat and Mass Transfer	3 (2+1)
	Basic Electrical Engineering	3 (2+1)
	Refrigeration and Air conditioning	3 (2+1)
	Dairy Engineering	3 (2+1)
	Dairy Process Engineering	3 (2+1)
	Instrumentation and Process Control	3 (2+1)
	Food Engineering	3 (2+1)
	Strength of Materials and Dairy Machine Design	3 (2+1)
	Dairy Plant Design and Layout	2 (1+1)
	Energy Conservation and Management	2 (1+1)
SEC modules****	Electrical Power supply and distribution in Dairy plant	2 (0+2)
	Introduction to AutoCAD/Solids works, Ansys, CFD for Design of Dairy machines and Layout	2 (0+2)
	Electrical and Control Systems in Dairy Plant	2 (0+2)
	Design, Operation and Maintenance of Cold Storage, Ice Bank tanks, Ice silo and refrigeration plant in Dairy plant	2 (0+2)

Course category	Course title	Credit Hours
	Capacity Design, operation and Maintenance of steam Boilers, Air compressor, DG set, Soft water plant, and other utilities in Dairy plant	2 (0+2)
	Hygiene and Safety Engineering	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Chemistry

Course category	Course title	Credit Hours
Core Courses	Biochemistry and Human Nutrition	2 (1+1)
	Physical Chemistry of Milk	2 (1+1)
	Chemistry of Milk	3 (2+1)
	Chemistry of Dairy Products	2 (1+1)
	Chemical Quality Assurance	2 (1+1)
	Food Chemistry	3 (2+1)
SEC modules****	Basic aspects of milk and milk products testing	2 (0+2)
	Nutritional evaluation of milk and milk products	2 (0+2)
	Malpractices in dairy industry: detection & control	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Microbiology

Course category	Course title	Credit Hours
Core Courses	Fundamentals of Microbiology	2 (1+1)
	Microbiology of Fluid Milk	2 (1+1)
	Microbiology of Dairy Products	2 (1+1)
	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
	Starter Culture and Fermented Dairy Products	2 (1+1)
	Food and Industrial Microbiology	2 (1+1)
SEC modules****	Food safety and hygiene	2 (0+2)
	Preparation and management of starter cultures for fermented milk products	2 (0+2)
	Basic microbiological tests for quality of milk and milk products	2 (0+2)
	ISO 22000 : Food Safety Management System	2 (0+2)
	FSSAI rules and regulations	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)
	BIS certifications for the dairy industry	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Business Management

Course category	Course title	Credit Hours
Core Courses	Farming based Livelihood System	2 (1+1)
	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Environmental Science and Disaster Management	3 (2+1)
	Communication Skills	2 (1+1)
	Personality Development	2 (1+1)
	ICT in Dairy Industry	2 (1+1)
	Operations Research	2 (1+1)
	Economic Analysis	2 (2+0)
	Agriculture Marketing & Trade	3 (2+1)
	Entrepreneurship and Business Management	3 (2+1)
	Financial Management and Cost Accounting	3 (2+1)
SEC modules****	International dairy trade	2 (0+2)
	Brand awareness : Major dairy companies and their brands	2 (0+2)
	Understanding operations of a sweet shop	2 (0+2)
	Market Survey on dairy and related aspects	2 (0+2)
	Market research : tools and techniques	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major & minor/s)	:	117
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/Online courses	:	08
Total	:	**172 + 08****

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

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

TABLE: CREDITS ALLOCATION SCHEME OF B.TECH. (DAIRY TECHNOLOGY) (Credit Hours)

Table 1: Credits Allocation Scheme of B.Tech. (Dairy Technology) Program (Credit Hours)

Semester	Core Courses-(Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	09	3[2]	3[10]	1[3] + 2[4]	4	-	22	2[1]		
II	15	-	3[6]	1[3] + 2[7]	4	-	25	-	10[12]	
III	14	3[9]	-	2[8]	2	-	21			
IV	17	3[5]	-	----	2	-	22	-	10[13]	08
V	22	-	-	-	-	-	22	2[11]		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**117**	**9**	**6**	**8**	**12**	**20**	**172**	**4**		**08**

Note: The credit hours mentioned in the table includes both theory and practicals.

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks' duration).

[2] Farming Based Livelihood Systems

[3] NCC/NSS/NSO (I& II)

[4] Communication Skills

[5] Entrepreneurship Development and Business Management

[6] Environmental Studies and Disaster Management;

[7] Personality Development

[8] Physical Education, First Aid and Yoga Practices

[9] Agriculture Marketing & Trade

[10] Agricultural Informatics and Artificial Intelligence

[11] Study tour (10-14 days)

[12] Only for those opting for an exit with UG-Certificate

[13] Only for those opting for an exit with UG-Diploma

Detailed Syllabi

SEMESTER-I

Deeksharambh (NG 02 week) 2 (0+2)

The newly inducted students should be acclamatized with the campus and be given an orientation of the degree programme. The *Deeksharambh* will be a week-long foundation course. The foundation course should be a primer for the new comer students about the nature of the degree program, processes and procedures of academic activities and orientation to various facets of the university. The outline of the foundation course is to be decided by the university or constituent college and can broadly include:

- Help for cultural Integration of students from different backgrounds,

- Know about the operational framework of academic process in university
- Instilling life and social skills
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

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

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

Workshop Practice **2 (1+1)**

Objectives

1. Understanding the basic requirements of workshop activities
2. Description of various tools, equipment and processes used in various shops
3. Developing general machining skills involved in production of machine elements

Theory

Introduction: workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry. Heat treatment process: Hardening, tempering, annealing and normalizing etc.

Metal work: Metal cutting. Soldering, Brazing. Welding: Electric arc and Gas welding.

Smithy and forging operations: tools and equipment.

Bench work: The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing.

Introduction to following tool machines: (a) Lathe Machine, (b) Milling Machine, (C) Shaper and Planner, (d) Drilling and Boring machines, (e) Grinder, (f) CNC Machines etc.

Practical

To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of

carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools (lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

Suggested reading

1. Arora, R. P. Basic Mechanical Engineering. Charotar Publishing House Pvt. Ltd., Anand (Guj.).
2. Chapman, W.A.J. and Martin, S. J. 1998. Workshop Technology. Part-III. Viva Books Private Ltd, New Delhi.
3. Raghuvanshi, B. S. 2002. Workshop Technology. Vol. 2. Dhanpat Rai & Co. (P) Ltd, Delhi.

Fluid Mechanics 2 (1+1)

Objectives

1. Understand the properties of fluid at rest and in transit
2. Understand how fluids move in response to differences in pressure
3. Derive and apply general equations for various fluid flows
4. Working principles of pumps and evaluation of their performance

Theory

Units and dimensions, Properties of fluids. Compressible and non-compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gauges, Piezometer.

Fluid flow: Classification, steady uniform and non-uniform flow, Laminar and turbulent, continuity equation, Bernolli's theorem and its applications. Flow through pipes: Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity.

Flow through mouthpieces, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge.

Dimensional analysis: Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude.

Pumps: Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Pump selection and sizing.

Practical

Study of various types of pipes and pipe fittings. Study of different types of valves. Study of reciprocating pump. Study of rotary gear pump. Study of piezometer. Study of U tube Manometer. Study of inclined tube Manometer. Study of Venturimeter. Determination of frictional coefficient of given pipe. Determination of minor head loss. Study of Pitot tube. Study the construction and working principle of centrifugal pump. Study of Reciprocating pump. Study and measurement of flow of liquid by V- notch.

Suggested reading

1. Jain, A. K. (1995). Fluid Mechanics. 8th edn. Khanna Publishers, New Delhi.
2. Kumar, K. L. (1996). Engineering Fluid Mechanics. S. Chand & Co., New Delhi.
3. Kumar, D.S. (1998). Fluid Mechanics. S.K. Kataria and Sons, New Delhi.
4. Rajput, R.K. (1998). A Textbook of Fluid Mechanics. S. Chand & Co., New Delhi.

Engineering Drawing 1 (0+1)

Objectives

1. Knowledge about different types of lines, representation of letters and numbers in drawing sheet
2. Learn to draw projections of lines, planes and solids etc.
3. Understand and draw isometric projections
4. Learn to convert the isometric view to orthographic view and vice versa

Practical

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale.

Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of vivet heads, types of riveted; joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

Suggested reading

1. Bhatt, N. D. and Panchal, V. M. 2006. Engineering Drawing: Plane and Solid Geometry. Charotar Publ. House Pvt. Ltd., Anand.
2. Bhatt, N. D. and Panchal, V. M. 2004. Machine Drawing. Charotar Publ. House Pvt. Ltd., Anand.
3. Narayana, K. L., Kannaiah, P. and Reddy, K. V. 2011. Machine Drawing. New Age International Publ., New Delhi.
4. Reddy, K. V. 2010. Textbook of Engineering Drawing. B.S. Publ., Hyderabad.

Fundamentals of Microbiology 2 (1+1)

Objectives

1. Understand the structural and functional differences among microorganisms
2. Understand the different systems used to classify microorganisms
3. Explicate the principles of microbial growth, nutrient requirements, and growth control methods

4. Explore microbial diversity and their ecological roles
5. Comprehend the fundamentals of microbial genetics and host-microbe interactions

Theory

History of Microbiology: Discovery of microorganisms and microscopy (types, principles, and applications). Early Microbiologists: Contributions of Leeuwenhoek, Pasteur, Tyndall, Lister, Koch, Jenner, and Fleming. Scope of Microbiology: Applications in dairy, food, pharmaceutical, industrial, medical, and agricultural fields.

Classification of Microbes: Microbial Classification Systems: Traditional and numerical taxonomy. Classification Schemes: Whittaker›s five kingdoms and Woese›s three-domain system. Bacterial Classification: Berge's Manual of Systematic Bacteriology, phylogenetic trees. Prokaryotic vs. Eukaryotic Cells: Structure and function of prokaryotic cells. Cell Wall Differences: Gram-positive vs. Gram-negative bacteria; Archaeal cell walls.

Microbial growth and nutrition: Bacterial growth curve; factors affecting growth of bacteria, direct and indirect methods of measurement of bacterial growth; Bacteriostatic and bactericidal agents; Common nutrient requirements and nutritional types of microorganisms.

Microbial Ecology: Micro flora of air, soil, and water; extremophiles (archaea). Basics of Microbial Genetics and Host-Microbe interactions: DNA as the genetic material, Structure of DNA/RNA, Genetic code, Central Dogma, DNA replication, transcription and translation.

Practical

General instruction for microbiological laboratory. Microscope -- simple and compound; Microbiological equipment; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Preparation of commonly used growth media (liquid and solid): simple and differential media. Isolation techniques for microorganisms – Streak, spread and pour plate. Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN). Visit to Microbiology Laboratory of Dairy/Food Industry.

Suggested readings

1. Black, J. G., & Black, L. J. (2018). Microbiology: principles and explorations. John Wiley & Sons.
2. Pelczar, M. J., Chan, E. C. S., & Kriec, N. R. (2017). Microbiology. Mc Graw Hill Education.
3. Pommerville, Jeffrey C. (2021). Fundamentals of Microbiology, 12th eEdition**.** by Jeffrey C. Pommerville (2021).
4. Powar, C. B., & Daginawala, H. F. (2004). General microbiology. Himalaya Publishing House.
5. Tortora, G. J., Case, C. L., Bair III, W. B., Weber, D., & Funke, B. R. (2004). Microbiology: an introduction.
6. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2011). Prescott's microbiology (Vol. 7). New York: McGraw-Hill.

Physical Chemistry of Milk 2 (1+1)

Objectives

1. Learn about compositional difference in milk of different species and breeds of milch animals
2. Develop comprehensive understanding of physical properties of milk and their role in stabilizing milk system
3. Understand how temperature and concentration of milk affect physical properties of milk and impact its stability
4. Acquire knowledge about instrumental methods of measurement of different physical properties of milk

Theory

Constituents and gross composition of milk of different species and breeds of milch animals, Colloidal State: Distinction between true and colloidal solution, lypophilic and lypophobic solution, properties of colloidal system. Gels-their formation and properties, Milk as a colloidal system and its stability, Elementary idea about emulsion.

Density: Density and specific gravity, pyknometer method, hydrometer lactometer, Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk, viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Liquid State: Surface tension, surface energy interfacial tension, Surface tension of milk and the factors affecting it.

Refractive index, Colligative Properties of Dilute Solution: Vapour pressure, Raoults Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk, Osmosis and Osmotic pressure, Inter-relation of colligative properties, Electrical conductance of milk, Buffer solutions. Derivation of Henderson – Hasselbach equation and its application, buffer capacity and buffer index, milk as a buffer system, Equilibrium of electrolytes. pH indicators.

Oxidation- Reduction: Redox potential, Nernst equation, Redox system of milk, Occurrence of radio nuclide in milk and milk products, Molecular Spectroscopy: The spectrum of electro-magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscope.

Practical

Determination of density and specific gravity of milk using pyknometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

Suggested reading

1. Ling, E. R. 2008. A Textbook of Dairy Chemistry. J. V. Publ. House, New Delhi.
2. Mathur, M.P., Datta, R.D., and Dinakar, P. 2005. Textbook of Dairy Chemistry. Indian Council Agricultural Research Publ., New Delhi.
3. Noble P. Wong, Robert Jenness, Mark Keeney, Elmer H. Marth.1996. Fundamentals of Dairy Chemistry. 3rd edn, Springer New York, NY
4. Walstra, P., Jenness, R. and Badings, H. T. 1984. Dairy Chemistry and Physics. 1st edn. Wiley-Inter science, New York.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in agriculture
3. To make the students familiar with agricultural-informatics, its components and applications in agriculture

Theory

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

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

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis,

automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

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

Suggested Readings

1. Date, C. J. (2005). Database in depth: relational theory for practitioners. O'Reilly Media, Inc.
2. Dhabal Prasad Sethi and Manoranjan. Concepts and Techniques of Programming in C. Wiley India.
3. Education Solutions Limited, I. T. L. (2005). Introduction to Information Technology. India: Pearson Education.
4. Mahapatra, Subrat K Et al. Introductory Agri-Informatics. Jain Brothers Publication MN.
5. Rajaraman, V., and Adabala, N. (2014). Fundamentals of computers. PHI Learning Pvt. Ltd.

Communication Skills 2 (1+1)

Objectives

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

Theory

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

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

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

Practical

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

Suggested readings

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

Farming Based Livelihood System 3 (2+1)

Objectives

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

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems.

Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood.

Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry,

duckry etc.), Horticultural crops, Agro-forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large-enterprises including value chains and secondary enterprises as livelihood components for farmers,

Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country,

Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and program by Central and State Government.

Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

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

Suggested Readings

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

8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

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

Objectives

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

Practical/ Awareness program

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline; Drill- aim, general words of command, attention, stands at ease, stand easy and turning; Sizing, numbering, forming in three ranks, open and close order march, and dressing; Saluting at the halt, getting on parade, dismissing, and falling out.

Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march; Marking time, forward march, and halt. Changing step, formation of squad and squad drill; Command and control, organization, badges of rank, honors, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.

Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

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

Objective

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

Practical/ Awareness program

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS;

Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.

Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.

Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.

Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

SEMESTER-II

Market Milk 4 (3+1)

Objectives

1. Learn about the salient features of the Indian and international dairy industry
2. Study procurement of milk and its reception in the processing plant
3. Learn homogenization, bactofugation and pasteurization of milk for retail distribution
4. Understand relevance and type of UHT plants, sterilization, processing induced changes in milk and aseptic packaging
5. Understand cleaning and sanitization practices followed in liquid milk processing plants

Theory

Dairy industry in India and abroad: Salient features. Collection and transportation of milk: (a) Organization of milk collection routes, (b) Practices for collection of milk, preservation at farm, refrigeration and natural microbial inhibitors.

Reception and treatment (pre-processing steps) of milk in the dairy plant: (a) Reception, chilling, clarification and storage: General practices, (b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) (c) Effect of homogenization on physical properties of milk, (d) Bactofugation: Theory and microbiology.

Thermal processing of milk: (a) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing, (b) Product control in market milk plant, (c) Defects

in market milk, (d) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized, vitaminised and sweet acidophilus milk, (e) Manufacture of sterilized milk, (f) Distribution systems for market milk.

UHT processing of milk**:** (a) Relevance of UHT processing in the tropical climate, (b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants, (c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems, (d) Technical control in the UHT plant, (e) Shelf life of UHT milk and tests for UHT milk.

Nutritive value of milk. Effect of heat processing on nutritive value. Cleaning and sanitization of dairy equipment.

Practical

Familiarization with equipment for reception of milk in plant; Pretreatments: Chilling, clarification, filtration; Standardization and numericals relating to it; Cream separation: parts of separator and the process; Operation of LTLT, HTST pasteurizer, laboratory steriliser; Preparation of special milks; toned, double toned, standardised, flavoured, sterilised; Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP; Detection of adulterants and preservatives in milk; Assessment of homogenisation efficiency in milk; Strength of common detergents and sanitizers used in market milk plant.

Suggested reading

1. Aneja, R.P. 1994. Dairying in India – A Success Story. Publication No. 1994/4. Asia Pacific Association of Agricultural Research Institutions (APAARI), Bangkok.
2. Banerjee, J.C. 2010. A Textbook of Animal Husbandry. Oxford and IBH Publishing Company Pvt. Ltd., Bombay
3. Cunningham, K.J. 2009. Rural and urban linkages: Operation Flood's role in India's dairy development. 37 pages. International Food Policy Research Institute (IFPRI) Discussion Paper 00924
4. Thompkinson, D.K. and Sabikhi, L. 2012. Quality Milk Production & Processing Technology. Xxvii+ 274 pp. New India Publishing Agency, New Delhi
5. www.fao.org/docrep/T3080T/t3080T07.htm
6. www.nddb.org/aboutnddb/operationflood.html

Heat and Mass 3 (2+1)

Objectives

1. Develop basic understanding of modes of heat transfer under steady and transient conditions
2. Acquire knowledge to apply basic principles of heat transfer to derive transfer co-efficients
3. Understand design and working of various heat transfer equipment
4. Acquire knowledge about basic concepts of mass transfer phenomenon and calculate mass transfer co-efficients

Theory

Basic heat transfer process: thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature.

One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines.

Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction.

Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient.

Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry.

Mass transfer: Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal diffusion. Mass transfer co-efficient and problems on mass transfer.

Practical

Determination of thermal conductivity: milk, solid dairy and food products. Determination of overall heat transfer co-efficient of: Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy and Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteurizer. Design problems on heat exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer Heat transfer in tubular heat exchanger: co current/ counter flow Heat transfer through composite wall. Heat transfer through legged pipes. Heat transfer through natural and forced convection.

Suggested reading

1. Domkundwar, S. (2008). A Course in Heat and Mass Transfer. Dhanpat Rai Publ., Delhi.
2. Eduardo Cao. (2010). Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
3. Green, Don W. Green and Robert H. Perry. (2008). Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Holman, J.P. Holman. (2010). Heat Transfer, 10th Ed. McGraw-Hill Book Co., Boston, USA.
5. Isachenko, V. P., Osipova, V. A. and Sukomel, A. S. (1977). Heat Transfer. Mir Publ., Moscow.

6. John H. Lienhard IV and John H. Lienhard V. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
7. Rajput, R. K. Rajput. (2008). Heat and Mass Transfer. S. Chand and Co., New Delhi
8. Semyonov, S. (1971). Fundamentals of Heat Transfer. Peace Publ., Moscow.
9. Semyonov, S. (1987). Problems in Heat and Mass Transfer. Mir Publ., Moscow.

Basic Electrical Engineering 3 (2+1)

Objectives

1. Learn about the basics of electrical circuits and networks
2. Understand the working, construction and characteristics of Electrical Motors
3. Develop understanding of operating principle and characteristics of DC machine and alternators
4. Acquire basic understanding of principles involved in power generation, transmission and distribution
5. Understand economics of electric power generation and its management

Theory

Alternating current fundamentals: Generation of alternating current or voltage, magnitude of induced E.M.F. Alternating current, R.M.S value and average value of an alternating current. Phase relation and vector representation. Cycle, Time period, Frequency, Amplitude, Phase and Phase Difference, Root – Mean Square Value, Average value, Form Factor, Crest or Amplitude Factor. Poly-phase Circuit: - Generation of Poly-phase Voltage, Phase Sequence, Interconnection of Three Phases such as Star Connection and Delta Connection and their respective value of current and voltages, Energy Measurement by using Single and Two Watt-meters.

Transformers: Working Principle of Transformer, Construction features of Core and Shell type transformer, Elementary theory of an Ideal Transformer, E.M.F. Equation of a Transformer, Vector diagram of transformer with and without load, Transformer losses, voltage regulation and efficiency of transformer, Construction and working on an Single Auto-transformer, Different parts of a 11/0.4 KV, Distribution Transformer.

Three Phase Induction Motor: Fundamental working principles, Production of rotating magnetic fields, construction, Different types of Rotor such as Squirrel Cage and Phase wound rotors, starting of induction motors using Direct on Line (DOL) and Star-Delta Starter. Soft starter and variable frequency drives.

Single Phase Induction Motors: Introduction, Different types of single phase induction motors such as Split Phase, Capacitor type, Shaded Pole type, Universal or AC series motors, Repulsion start induction run motor, Repulsion – induction motor.

DC Machine: Construction and operation of DC generator, types of generators and their various characteristics. DC motors: Torque speed characteristics of DC motors, Starting and speed control of DC motors by using 3-point DC Starter.

Alternators: Elementary working principles, Different parts of an Alternators, Relation between Speed and Frequency, E.M.F. equation in an Alternators. Different types of Circuit Breaker and its use. Introduction to DG set system.

Electric Power Economics: Economics of Generation of electrical energy and related important terms such as, load curve, connected load, Maximum Demand, Demand Factor, Average load or demand, Load Factor, Diversity factor and its significance, Capacity Factor or Plant factor, Utilization Factor, Plant Operating Factor and Selection of Units and related numerical, Various types of Tariff used for calculation of electricity bill.

Lighting system: Introduction to industrial lighting system. Energy Management and Power Factor Corrections: Types of energy, Energy Management, Concept of Energy Audit. Concept of Power Factor, Disadvantages of low power factor, causes of low power factor, Various methods of improving low power factor, Location of power factor correction equipment, Advantages of power factor improvement.

Practical

Introduction to various basic circuits of parallel wiring, stair case wiring, fluorescent light fitting; Study of voltage and current relationship in case of Star connected load; Study of voltage and current relationship in case of Delta connected load; Measurement of power in 3-phase circuit; for a balanced load, using watt meters. Measurement of power in 3-phase circuit; for a unbalanced load, using watt meters. Measurement of iron losses of Single Phase transformer by conducting open circuit test; Measurement of Copper losses of Single Phase transformer by conducting short circuit test. Starting and reversing the speed of a single phase induction motor; Starting and reversing the speed of a three phase induction motor using Direct on Line (DOL) Starter; Starting and reversing the speed of a three phase induction motor using manual Star Delta Starter; Starting and reversing the speed of a DC shunt motor using 3-point DC Starter; Starting of slip-ring induction motor by manual and automatic Slip-ring Induction Motor Starter; To determine the relation between induced armature voltage and speed of separately /self excited DC Shunt Generator.

Suggested reading

1. Anwani, M.L. and Anwani, I. (1972). Basic Electrical Engineering (I.T.I), Dhanpat Rai & Co. (P) Ltd., Delhi.
2. Gupta, J.B. (2010). Electrical Measurements and Measuring Instruments. S.K. Kataria & Sons, New Delhi.
3. Rajput, R.K. (2004). A Textbook of Electrical Technology. Laxmi Publ., New Delhi.
4. Rajput, R.K. (2007). Basics of Electrical and Electronics Engineering. Laxmi Publ., New Delhi.
5. Singh, S. (2005). Electrical Estimating and Costing, Dhanpat Rai & Co. (P) Ltd., Delhi.
6. Theraja, B. L. (1961). Fundamentals of Electrical Engineering and Electronics. S. Chand & Company Ltd., New Delhi.
7. Theraja, B.L. (1959). A Textbook of Electrical Technology. Vol. I & II. S. Chand & Co., Ltd., New Delhi.

Microbiology of Fluid Milk 2 (1+1)

Objectives

1. Learn about the types of microorganisms present in milk and sources of contamination
2. Study the types of microbial spoilage of milk and mechanisms of spoilage

3. Understand measures required for clean milk production and natural antimicrobial substances present in milk
4. Acquire knowledge about thermal processing of milk for enhancing quality and safety of milk
5. Learn about public health concerns arising out of microbial contaminants present in milk

Theory

Microbes associated with raw milk: Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their morphological and biochemical characteristics and classification. Significance of spore and spore-forming bacteria in milk, Microbial contaminants in raw milk, their sources during various stages of production - milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms; Microbiological changes in bulk refrigerated raw milk.

Concept of clean milk production: Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipment and dairy farm environment; Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoproxidase (LP) system. Somatic cells in raw milk: Significance and measurement.

Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavors and discolouration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health.

Microbiological aspects of fluid milk: Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal (pulsed field) micro-filteration, bactofugation, standardization and homogenization. Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk. Bio-film formation during processing and their control measures.

Public health aspects of fluid milk: Microbial zoonotic diseases transmitted through fluid milk; Milk borne diseases -food infection, intoxication and toxi- infection caused *E. coli, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Shigella species, Campylobacter* etc. Microbiological grading and legal standards of raw and processed milk.

Practical

Morphological examination of common dairy microorganisms (size and shape, arrangement and sporulation); Estimation of microbial load in raw milk by standard plate count (SPC) and dye reduction tests (MBRT, RRT); Grading of processed/ market milk by Aerobic plate count (APC), coliform and methylene blue reduction time; Enumeration of psychrotrophic, thermophillic, thermoduric and spore forming bacteria in raw and market milk; Detection of sources of contamination: Air, water, utensils, equipment and personnel, line testing; Spoilage of milk caused by microorganisms: souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discolouration; Detection of mastitis milks: pH, SLST, somatic cell count, chloride content, Hotis test and CAMP test. Detection and estimation of coliforms: presumptive, rapid coliform and IMViC Test.

Suggested reading

1. Britz, T.J. and Robinson, R.K. 2008. Advanced Dairy Science and Technology. 1st ed. Blackwell Publ. Ltd., UK.
2. Fernandes, R. 2009. Microbiology Handbook: Dairy Products. Royal Society of Chemistry, Revised ed., London.
3. Marth, E.H. and Steele, J. 2001. Applied Dairy Microbiology. 2nd ed. CRC Press, Boca Raton, USA.
4. Papademas, P. (Ed.). 2014. Dairy microbiology: a practical approach. CRC Press.
5. Prajapati, J.B and Behare, P.V. 2018. Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, New Delhi. ISBN: 978-81-7164-182-6.
6. Robinson, R.K. 2002. Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products. 3rd ed. Wiley-Interscience, New York.
7. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.

Chemistry of Milk 2 (1+1)

Objectives

1. Learn about the chemical constituents present in milk and factors affecting its composition
2. Develop understanding about different fractions of milk proteins, their properties, methods of estimation and genetic polymorphism
3. Acquire knowledge about milk carbohydrates, their properties and changes brought about by processing interventions
4. Learn about milk lipids, structure of glycerides and factors affecting fatty acids composition
5. Understanding of importance of minor milk constituents such as phospholipids, vitamin D and minerals present in milk

Theory

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins: α-Lactalbumin and β-Lactoglobuline. Properties of α-Lactalbumin and β-lactoglobulin, Immmunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins.

Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase.

Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re-arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose.

Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins.

Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

Practical

Sampling techniques of chemical examination of milk; Determination of pH and titratable acidity of milk; Determination of fat in milk by different methods; Determination of total solids and solids not fat in milk; Determination of total milk proteins by Kjeldahal method; Determination of casein, whey proteins and NPN in milk; Estimation of alkaline phosphatase and lipase in milk; Determination of lactose in milk; Determination of ash in milk; Determination of phosphorus and calcium in milk; Determination of chloride in milk; Determination of temporary and permanent hardness of water; Estimation of available chlorine from bleaching powder.

Suggested reading

1. Fox, P.F. (Ed). (1982). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
2. Fox, P.F. and Sweeny, Mc. (1998). Dairy Chemistry and Bio-Chemistry. Academic /Platinum Publ., NewYork.
3. Fox, P.F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
4. Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi.
5. Mathur, M.P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi.
6. Walstra, P. and Jenness, R. (1984). Dairy Chemistry and Physics. Wiley – Inter Sci. Publ., John Wiley and Sons, USA.
7. Webb, B. H., Johonson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

1. Understand different resources such as mineral resources, food resources, water resource, energy resources, natural resources and land resources
2. Gather knowledge about environmental pollution, soil pollution, air pollution and thermal pollution
3. Acquaint themselves with waste land reclamation, ecosystems and their management
4. Learn regarding biodiversity and its conservation, natural disaster and manmade disaster along with their management

Theory

Multidisciplinary nature of environmental studies; definition, scope and importance; Natural resources: renewable and non-renewable resources, natural resources and associated problems; Forest resources: use and over-exploitation, deforestation, case studies; Timber extraction, mining, dams and their effects on forest and tribal people; Water resources: use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems;

Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies; Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles; Ecosystems: concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of ecosystems as forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: introduction, definition, genetic, species and ecosystem diversity and biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Environmental pollution: definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution.

Social issues and the environment: from unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management.

Environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Dies, wasteland reclamation; Consumerism and waste products; Environment protection act; Air (prevention and control of pollution) act; Water (prevention and control of pollution) act; Wildlife protection act. Forest conservation act; Issues involved in enforcement of environmental legislation; Public awareness.

Human population and the environment: population growth, variation among nations, population explosion, family welfare programme; Environment and human health: human rights, value education, HIV/ aids; Women and child welfare; Role of IT in environment and human health.

Natural disasters- meaning and nature of natural disasters, their types and effects; Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

Man-made disasters- nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster management- effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community based organizations and media, Central, state, district and local administration; armed forces in disaster response; disaster response; police and other organizations.

Practical

Pollution case studies; Case studies- visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain; Visit to a local polluted siteurban/rural/industrial/agricultural; Study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.; Collection of polluted water/ effluent sample, sampling of polluted water/ effluents; Estimation of solids, pH, EC, DO, COD, BOD, Cl^-, F^-, CO_3^{2-}& HCO_3^-, Ca^{2+}& Mg^{2+}, K^+ and Na^+.

Suggested Reading

1. Anjaneyulu Y. 2004. Introduction to Environmental Science. BS Publications. Hyderabad.
2. Asthana D K and Asthana M. 2007. *Environment Problems and Solution*. S. Chand & Company, New Delhi.
3. Chauhan A S 2014. Environment Studies. Jain Brothers. Karol Bagh, New Delhi.
4. Dhaliwal G S and Kukal S S 2005. Essentials of Environment Science. Kalyani Publishers. Ludhiana.
5. Etherington J R. 1982. *Environment and Plant Ecology*. 2nd Edition. Wiley–Blackwell.
6. Kukal S S and Kingra P K 2019. Introduction to Environment and Disaster Management. Kalyani Publishers. Ludhiana.
7. Mahi G S and P K Kingra 2018. Fundamentals of Agrometeorology and Climate Change. Kalyani Publishers. New Delhi.
8. Saha A K. 2006. Text Book of Soil Physics. Kalyani Publishers. Ludhiana.
9. Sharma P D. 2010. Ecology and Environment. Rastogi Publishers. New Delhi.
10. Singh M P. 2004. *Environment and Pollution*. Anmol Publications Pvt Ltd.
11. Status of Forest Report 2019 Forest Survey of India. Dehradun.

Personality Development 2(1+1)

Objective

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

Theory

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

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution.

Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence-types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

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

Suggested reading

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

NCC-II 1 (0+1)

Objectives

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

Practical/ Awareness program

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

Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding:

Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

Introduction to map, scales, and conventional signs. Topographical forms and technical terms.

The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.

Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks.

Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

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

Objective

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

  Practical/ Awareness program

Importance and role of youth leadership; Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies; Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations;

Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

SEMESTER-III

Thermodynamics **3 (2+1)**

Objectives

1. Acquire fundamental understanding of the principles of thermodynamics and heat transfer
2. Understand mathematical and practical aspects of heat transfer by conduction, convection and radiation
3. Develop understanding of thermodynamic properties of substances in gas and liquid states
4. Learn about the concept, type and working principle of different systems of internal combustion engines
5. Understand the classification, design and operation of steam generators

Theory

Importance and applications of thermodynamics in Dairy/Food processing. Basic concepts: Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of Thermodynamics.

Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. Analysis of non-flow and flow processes. The second

Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability.

Air Cycles: Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. I.C. Engines: Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines. Fuels.

Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. Properties of steam: Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption.

Steam generators: Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis.

Air Compressors: Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

Practical

A visit to dairy/ food processing plant showing the thermodynamics applications/ devices; Study of 2-stroke and 4-strokes IC engines working; Study of S.I. and C.I. engines working; Study of modern fuel injection systems of I.C. engines; Study of diesel fuel supply system (pump and fuel injector) of I.C. engine; Study of fuel supply system of a petrol engine; Study of cooling system of an I.C. engine (air cooling and water cooling); Study of lubrication system of I.C. engine; Study of Solar water heater and biogas plants and appliances; To study different types of boilers with the help of Lab models; To study Boiler mountings and steam-line layout and steam traps; Industrial exposure visit to plant with steam utilization; Study of Fire tube low pressure boiler installed in a dairy processing plant; Study of water softening plant installed with boiler in a dairy processing plant; Study the construction and working of Cochran boiler. Study of Babcok and Wilcox boiler. Study of different Boiler accessories.

Suggested reading

1. Arora, C.P. 1998. Thermodynamics. Tata McGraw- Hills Publ. Co., New Delhi.
2. Chattopadhyay P. Chattopadhyay 2000 Boiler Operation Engineering: Questions and Answers, McGraw-Hill
3. Steam Plant Operation 2017 Everett B. Woodruff, Herbert B. 2017. Steam Plant Operation. Lammers & Thomas F. Lammers. McGraw-Hill Education
4. Gupta, C.P. and Parkash, R. 1996. Engineering Thermodynamics. New Chand & Bros., Roorkie (UP).
5. Khurmi, R.S. and Gupta, J.K. 2004. A Textbook of Thermal Engineering. S. Chand & Co. Ltd., New Delhi.
6. Nag, P.K. Nag.2005. Engineering Thermodynamics, 3rd Ed. Tata-McGraw-Hill Education, New Delhi.

7. Rajput, R.K. Rajput. 2007. Engineering Thermodynamics, 3rd edn. Laxmi Publications (P) Ltd., Beangaluorue.
8. Smith, J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
9. STEAM/its generation and use 42nd edition. The Babcox and Willcox company.

Traditional Indian Dairy Products 3 (2+1)

Objectives

1. Understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
2. Learn about the chemical composition and legal standards for traditional Indian sweets
3. Acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
4. Learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milk-cake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.

Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process.

Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti Dahi: Product description method of manufacture and packaging process.

Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakand, Milk cake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, Misti Dahi, Chhana and Shrikhand; Visit to industry.

Suggested reading

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India
2. Agarwala, S.P. (2006). Equipment for paneer making, Lecture compendium on developments in traditional dairy products. Short course organized by CAS from Dec. 10-30, 2006: pp-132-137.
3. Dharam Pal and Narender Raju, P. (Eds). (2006). Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course, CAS in Dairy Technology, NDRI, Karnal.
4. Pal, D. (1997). Technology of the manufacture of rabri and basundi. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRl Deemed University, Karnal.

Dairy Engineering 3 (2+1)

Objectives

1. Learn about sanitary pipes and fittings and systems used for cleaning operations in dairy plants
2. Understand design and operation of various mechanical separations systems and devices used in the dairy industry
3. Acquire knowledge of design and operation of thermal processing systems such as pasteurizer, sterilizer and UHT processing plants
4. Learn about pouch filling and aseptic packaging machines for packaging of processed liquid milk

Theory

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes and fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system.

Mechanical Separation: Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers.

Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.

Thermal Processing: (a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, Arrhenius equation, D value, Z value, F value, Q_{10} value. (b) Factors affecting thermal destruction of microorganisms.

Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers.

Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance.

Mixing and agitation: Theory and purpose of mixing. Equipment used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

Practical

Study of S. S. pipes, fitting and gaskets; Study and selection of pump; Study of different types of milk filter; Study of equipment at raw milk reception dock; Constructional details, operation and maintenance of straight through can washer; Constructional details, operation and maintenance of C.I.P. system; Constructional details, operation and maintenance of homogenizers; Constructional details, operation and maintenance of batch pasteurizer; Constructional details, operation and maintenance of HTST pasteurizer; Comparison of conventional and modern pasteurizer; Constructional details, operation and maintenance of cream separators; Constructional details, operation and maintenance of sterilization systems; Constructional details, operation and maintenance of pouch filling machine; Constructional details, operation and maintenance of different types of agitators; Constructional details, operation and maintenance of bottle filling and capping machine; Visit to a dairy processing plant.

Suggested reading

1. Ahmad, T. 1985. Dairy Plant Systems Engineering. Kitab Mahal Publ., Allahabad.
2. Dairy Processing Handbook. 1995. Tetra Pak Processing Systems AB, Sweden.
3. Kessler. 1981. Food Engineering and Dairy Technology. V.A. Kessler Publ., Freising, Germany.
4. McCabe, W., Smith, J. and Harriott, P. 1993. Unit operations of Chemical Engineering. Mc-Graw Hill Inc. New York.
5. Towler, G. and Sinnott, R. 2008. Chemical Engineering Design. Elsevier, New York.

Refrigeration and Air Conditioning 3 (2+1)

Objectives

1. Understand the fundamental principles of refrigeration and air conditioning
2. Make comparative study of different refrigerants with respect to properties and applications
3. Learn to calculate the cooling/heating load for different applications
4. Understand the principle of psychometric processes and air conditioning
5. Design and implement refrigeration and air conditioning systems as per the recommended standards

Theory

Basic refrigeration cycles and concepts: Standard rating refrigerating machines; Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle; Departure from theoretical vapour compression cycle, representation on T-S and p-h diagrams; Mathematical analysis of vapour compression refrigeration system.

Refrigerants: Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, HFC, HCFC etc.); Brine, their properties and comparison. Multi-Pressure Refrigeration Systems: Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems.

Refrigeration Equipment and Controls: Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation.

Design and Balancing of Refrigeration System: Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis.

Cryogenic Freezing: Cryogenics, cryogens, properties, applications, cryogenic freezers. Psychrometry: Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls.

Air-conditioning Systems: Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. Cold Storage: Types of cold storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

Practical

Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools; Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler; Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant; Estimation of installed cooling capacity with the help of observed working pressures; Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT); Study of specifications, components, operation, control and maintenance of a Cold Storage; Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc.; Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications; Study of different types of capacity control devices used with compressors in a refrigeration plant; Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up (Comparison of actual and theoretical performance); Experimental study of a year-round air-conditioning system on an air-conditioning tutor or an experimental set-up; Determination of SHF and By-pass factor etc; Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor; Measurement of psychrometric

properties using psychrometric meters/gadgets; Industrial exposure visit to refrigeration/air-conditioning plant.

Suggested reading

1. Arora, S. C. and Domkundwar, S. 2018. A Course in Refrigeration and air conditioning. 5th ed. Dhanpat Rai and Sons, Delhi.
2. Arora, C. P. 2000. Refrigeration and air conditioning. Tata McGraw-Hill, New Delhi.
3. Ballaney, P. L. 1992. Refrigeration and air conditioning. Khanna Publ., New Delhi.
4. Jorden, R. C. and Priester, G. B. 1957. Refrigeration and air conditioning. Prentice-Hall, New Delhi.
5. Prashad, M. 2007. Refrigeration and air conditioning. New Age International, New Delhi.

Starter Culture and Fermented Dairy Products 2 (1+1)

Objectives

1. Understanding basic aspects of different types of starter cultures, their metabolism, storage and propagation
2. Understand preservation of starter cultures, tests for evaluating activity and purity as also factors affecting their survival and activities
3. Learn about the role of starter cultures in preparation of various fermented milk products and defects appearing as a result of improper starter activities
4. Acquire knowledge about cheese starter cultures and their role in development of desirable properties during processing and ripening

Theory

Types, metabolism and propagation of starter cultures: History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters; Probiotics and special cultures like exopolysaccharide, vitamin and low calorie sugar producing cultures; Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, factors affecting propagation; Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits. Prebiotic, postbiotic and symbiotic concepts.

Activity, Purity, Preservation of Starters and Starter Failure: Quality and activity tests for dairy starters and their preservation- methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation; Defects in starters and their control; Starter failures- effect of antibiotic residues, sanitizers and bacteriophages. Phages-life cycle, sources, prevention, chemical and mechanically protected systems for starter culture production.

Role of Starters in fermented milks: Role of starters in the preparation of various fermented milks; Types of fermented milks - dahi, yoghurt, acidophilus milk; different types of dahi and yoghurt; preparation; defects and their control. Kefir and koumiss: origin and characteristics; microbiology of kefir grains; Other fermented milks such as Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Microbiology of fermented milk products; their nutritional and therapeutic significance.

Chesse Starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant chymosin

Practical

Testing purity of starter cultures by gram's staining, catalase test; creatine test; Testing starter activity by dye reduction tests, Horrall-Elliker, White Head and Cox test; Preparation of single and mixed starter cultures; Evaluation of homo-fermentation and hetero-fermentation separately and in combination; Preservation of starter cultures by freeze-drying techniques; Preparation of concentrated starter (DVS); Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Preparation and microbial examination of dahi, *lassi*, *shrikhand*, yoghurt, cultured butter milk, acidophilus milk and kefir; Analysis of cheese for total spore and anaerobic spore count; Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening).

Suggested Readings

1. Bagchi, D., Lau, F.C. and Ghosh, D.K. (2010). Biotechnology in Functional Foods and Nutraceuticals. CRC Press LLC, USA.
2. Cogan, T.M. and Accolas, J.P. (1995). Dairy Starter Cultures. VCH Publ., USA.
3. Farnworth, E.R. (2008). Handbook of Fermented Functional Foods. 2nd edn. CRC Press, USA.
4. Full, R. and Perdigon, G. (2000). Probiotics – 1, 2, 3. Kluwer Academic Publ., Dordrecht, Netherlands.
5. Hutkins, R.W. (2006). Microbiology and Technology of Fermented Foods. Blackwell Publ. Professional, Iowa, USA.
6. Kosikowski, F.V. and Mistry, V.V. (2001). Cheese and Fermented Milks. Kosikowaski and Sons, Westport, CT.
7. Law, B.A. (1997). Microbiology and Biochemistry of Cheese and Fermented Milks. 2nd edn. Blackie, New York.
8. Prajapati, J. B and Behare, P. V. (2018). Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, New Delhi. ISBN: 978-81-7164-182-6.
9. Puniya, A.K. (2015). Fermented Milk & Dairy Products; CRC Press/ Taylor & Francis (ISBN 9781466577978); pp 1-714

Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets

3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

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

Marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark).

Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs.

Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

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

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

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

SEMESTER-IV

Cheese Technology 5 (3+2)

Objectives

1. Learn about history of cheese making and evolution of different varieties of cheeses with distinctly different attributes
2. Understand how quality of milk and various additives play critical role in good cheese making
3. Acquire knowledge about the role of rennet and starter cultures in progression of chemical and biochemical processes responsible for desirable cheese quality attributes
4. Develop skills to manufacture good quality cheeses of both fresh and ripened varieties
5. Learn about new processing interventions for improving yield and accelerating ripening for improving economics of production of cheese

Theory

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese.

Milk quality in relation to cheese making. Pre-treatment of milk for cheese making; Physical and chemical additives and preservatives for cheese making. Rennet preparation and properties, milk clotting enzymes as rennet substitutes: plant, animal and microbial origin. Action of rennet on milk in relation to cheese making. Biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi soft, semi hard, hard, acid coagulated cheese.

Cheese starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; Manufacture of different choice-based varieties of cheese: Cheddar, Gouda, Swiss Mozzarella, Cottage, Cream and Quarg. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of

processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Practical

Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on cheese starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Familiarization with equipments, accessories and standardization numericals; Study of factors affecting rennet action; Determination of Rennet Cogaulation Time (RCT) of milk, Manufacture of Cheddar cheese; Manufacture of Gouda cheese; Manufacture of Mozzarella cheese; Manufacture of Swiss cheese; Manufacture of Cottage cheese; Manufacture of Processed cheese; Manufacture of Processed cheese spread; Manufacture of Processed cheese food.

Suggested reading

1. Cheese. (2010). A global strategic business report. Global Industry Analysts, Inc
2. Banks, J.M. (1998). The Technology of Dairy Products. 2nd edn. R. Early (Ed.), Chapman and Hall, Blackie Academic and Professional, London,
3. Kapoor, R. and Metzger, L. E. (2008). Process Cheese: Scientific and Technological Aspects—A Review. Comprehensive Reviews in Food Science and Food Safety. 7, 194-214.
4. Singh, S. (2011). Production and Marketing of Cheese – A Global Perspective. Lecture Compendium on Advances in Cheese and Fermented Products (Centre of Advanced Faculty Training), 1-8http://www.strategyr.com/Cheese_Market_Report.asp
5. Cheese (2017) Chemistry, Physics and Microbiology 4th ed Paul McSweeney, Paul Cotter, David Everett (Ed) Elsevier Publications, USA.
6. Patrick F. Fox, Timothy P. Guinee , Timothy M. Cogan , Paul L. H. McSweeney, (2018) Fundamentals of Cheese Science. Springer New York, NY.

Fat-Rich Dairy Products 3 (2+1)

Objectives

1. Understand manufacture of different types of creams, its packaging, marketing and quality control
2. Learn about the processes involved in making butter and spreads using batch and continuous methods, their packaging and quality
3. Learn ghee making methods, factors affecting its quality, packaging and legal standards required for marketing

Theory

Status of fat-rich dairy products in India and abroad. Cream: (a) Definition and Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. (b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. (c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT

processing of cream. (d) factors affecting quality of cream; ripening of cream. (e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: (a) Introduction to the butter making process; theory of churning, Legal standards. (b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine.

Special butters and related products: (a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. (b) Manufacture, packaging, storage and characteristics of margarine of different types.

Ghee and butter oil: (a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. (b) Ghee: Composition and changes during manufacture fat constants. (c) Butteroil: Manufacture of butteroil, packaging and storage.

Practical

Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

Suggested reading

1. Anantakrishnan, C.P. and Srinivasan, M.R.1964. Milk Products of India. ICAR Publications, New Delhi.
2. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. Technology of Indian Milk Products. A Dairy India Publication, Delhi.
3. De, S.1980. Outlines of Dairy Technology. Oxford University Press, Delhi.
4. Rangappa, K.S. and Acharya, K.T. 1974. Indian Dairy Products. Asia Publishing House, New Delhi.

Ice-Cream and Frozen Desserts 3 (2+1)

Objectives

1. Understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
2. Learn about design and working of Ice cream freezers including cleaning and sanitization
3. Aquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
4. Learn about the defects that appear in ice cream, causative factors and measures to control them

Theory

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts.

Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture.

Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant.

Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention.

Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Suggested reading

1. Arbuckle, W.S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut.
2. Hall, C.W. and Hedric, T.T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338
3. Hui, Y.H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley – VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
5. NDRI. 1998. Advances in Ice Cream and Frozen Desserts. Lecture compendium, Sixth short course, Dec15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.
8. Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th edn. Madison, Wisconsin, p 5-10.

Chemistry of Dairy Products 3 (2+1)

Objectives

1. Acquire knowledge about composition and legal standards for different types of dairy products

2. Understand about the physico-chemical changes that take place during manufacture of dairy products as a function of processing variables
3. Learn about various deteriorative reactions that occur during storage of dairy products and measures to control them

Theory

Chemical composition and legal standards of milk products. Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants.

Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, Shrikhand.

Chemistry of cheese: milk clotting enzymes, enzymatic coagulation of milk, biochemical changes during ripening. Physico-chemical changes during preparation and storage of concentrated and dried milk products.

Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.

Practical

Cream: estimation of fat and acidity; Butter: estimation of fat, moisture, curd and salt content; Ghee: estimation of moisture, acid value, Butyro refractive reading and Reichert Meissl value / Polanske value; Determination of lactose and sucrose in sweetened condensed milk; Milk powder: moisture, fat, ash, solubility, acidity and bulk density; Ice cream: estimation of fat and total solids; Estimation of moisture, fat and salt content in cheese; Khoa/paneer: estimation of moisture and fat; Estimation of protein content in milk products and protein rich dairy products using Kjeldahl method.

Suggested reading

1. Fox, P. F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork.
2. Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi.
3. Mathur, M. P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi.
4. Megh R. Goyal, Suvartan G. Ranvir, Junaid Ahmad Malik. (2023). The Chemistry of Milk and Milk Products-Physicochemical Properties, Therapeutic Characteristics, And Processing Methods. AAP, CRC Press (Taylor & Francis Group).
5. Varnam, Jane and Sutherland, P. (2001) Milk and Milk Products: Technology, Chemistry and Microbiology. Springer Science & Business Media
6. Webb, B. H., Johonson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi.

Microbiology of Dairy Products 2 (1+1)

Objectives

1. To learn about entry of spoilage and pathogenic microorganisms vis-à-vis microenvironment of processed dairy products, their spoilage mechanism and preventive measures
2. Understand the type of microorganisms that could enter fat rich dairy products, condensed or dried milk, frozen and traditional dairy products
3. Learn about microenvironment of each of the dairy products and how they influence growth of these microorganisms which in turn cause spoilage
4. Understand critical processing factors that impact presence of different types of microorganisms and control measures to prevent spoilage and health hazards
5. Learn about microbial safety concerning to potential pathogens and their public health significance

Theory

Microbiology of Cream and Butter - Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/un-ripened cream), sterilized and UHT cream; Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. Fungal spoilage of Ghee.

Microbiology of Condensed, Evaporated and Dried products: Type of microorganisms associated with condensed and evaporated milk, their growth/ survival during manufacture and storage; Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/ bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk; pre-heating/DSI temperature and their impact on microflora of dried products.

Microbiological aspects of milk powder with respect to manufacturing steps and types of powder (heat classification of powders), Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. Microbiology of Infant Milk Formula (IMF).

Microbiology of Ice Cream and Frozen desserts: Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards.

Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfietc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Comparison of dairy sweets made at sweet shops vs. commercially manufactured sweets. Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards.

Practical

Microbiological examination of raw, pasteurized, sterilized and UHT cream for Standard plate count (SPC) as well as lipolytic and coliform counts, direct microscopic count (DMC), dye reduction tests and sterility test ; Microbiological examination of salted and unsalted butter for SPC, psychrotrophic, lipolytic, coliforms and yeast and mold count; K.Q test; Microbiological examination of concentrated milk for SPC, coliforms, spores, yeast and mold, thermoduric and thermophilic counts; Microbiological examination of dried milks for SPC, coliforms, *Staph. aureus*, *B. cereus, E. coli, Salmonella*, Sulphite reducing clostridia and Staphylococcal enterotoxins; Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms and Staphylococcal counts; Detection of *Salmonella* spp./*E. coli*; Microbiological examination of khoa for SPC, coliforms and staphylococcal counts besides yeast and mold counts; Microbiological examination of paneer and shrikhand for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts; Microbiological examination of Kheer for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts.

Suggested reading

1. Marth, E.M. and Steele, J.L. (1998). Applied Dairy Microbiology. Marcel Dekker, New York.
2. Marth, Elmer H. Marth and Steele, James Steele (2001) Applied Dairy Microbiology CRC Press
3. Palmiro, Poltronieri (2017) Microbiology in Dairy Processing: Challenges and Opportunities. John Wiley & Sons.
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7. Salminen, S. and Wright, A.V. (1998). Lactic Acid Bacteria. Marcel Dekker, New York.
8. Yadav, J.S., Grover, S. and Batish, V.K. (1993). A Comprehensive Dairy Microbiology. Metropolitan Publishers, New Delhi.

ICT in Dairy Industry 2 (1+1)

Objectives

1. Learn about computers and its operating environment for organizing, storage and retrieval of data
2. Understand application of computer as dairy management tools to describe, document and control all processes in the dairy industry
3. Learn about project management tools for project scheduling and monitoring for timely completion and implementation of information system
4. Develop competence in process modelling and simulation for product design and manufacturing to deliver good quality dairy products
5. Learn about newer applications of AI and Robotics in the dairy plant operations

Theory

Importance of Computerization and IT in dairy industries. Computers, Operating. Environments and Information Systems for various types of dairy Industries.

Principles of communication. Role of Computer in Optimization; Introduction to Operation. Research.

A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modelling and Simulation.

Introduction to SCADA and INTELUTION. CAD and CAM in Dairy Industries: Instrumentation, Process control, Inventory control, Automation, Robotics, Expert Systems and Artificial Intelligence, Instrumentation.

Practical

Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food. Chemical kinetics in dairy processing. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit and Vegetable processing unit. Familiarization with software related to dairy industry

Suggested reading

1. Balagurusamy, E. 2009. Fundamentals of Computers. Tata Mcgraw-Hill, New Delhi.
2. Britz, T. J. and Robinson, R. K. 2008. Advanced Dairy Science and Technology. Blackwell Publication, UK.
3. Elmasri, R. and Navathe, S. B. 2008. Fundamentals of Database Systems. 5th ed. Pearson Education, New Delhi.
4. Forouzan, B. A. 2012. Data Communication and Networking. 4th ed. Tata McGraw-Hill, India.
5. Goyal, D.P. 2000. Management Information Systems. 2nd ed. Macmillan Publishers, India.
6. Mishra, T.N. and Kirmani, M.M. 2004. System Analysis and Design. CyberTech Publishers, India.
7. Obrien, J. A., and Marakas, G. M. 2006. Management Information System. 7th ed. Tata McGraw-Hill, New Delhi.
8. Patterson, D.W. 2007. Introduction to Artificial Intelligence and Expert Systems. Prentice Hall, India.
9. Rajan, E.G. 2003. Information Technology. BS Publication, Hyderabad.
10. Rajaraman, V. 2002. Fundamentals of Computers. 3rd ed. Prentice Hall of India, New Delhi.
11. Shmulei, G., Patel, N. R. and Bruce, P. C. 2008. Data Mining for Business Intelligence. Wiley Interscience, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

1. To expose the student to various aspects of establishment and management of a small business unit
2. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development.

Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities.

Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

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

Suggested Readings

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

10. Tripathi P. C. and Reddy P. N., 1991, Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997, Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

SEMESTER-V

Condensed and Dried Milk 4 (3+1)

Objective

- To learn manufacture of condensed milk and milk powders and understand factors affecting its quality as a function of raw milk quality and processing variables

Theory

Condensed milks: History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques; (a) Manufacture of evaporated milk including pilot sterilization test, (b) Manufacture of sweetened condensed milk, (c) Recombined sweetened condensed milk.

Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention. Recent advances with reference to freeze concentration and membrane concentration.

Dried milks**:** History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders.

Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk.

Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.

Practical

Manufacture of plain skim concentrated milk; Manufacture of Sweetened Condensed Milk; Manufacture of Evaporated Milk; Concentration of milk by membrane processing; Manufacturing of Skim Milk Powder by spray drying/roller drying; Manufacture of instant milk powder.

Suggested reading

1. Caric´, M. 1994. Concentrated and Dried Dairy Products. VCH, New York.
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3. Fox, P.F. and McSweeney, P. 2003. Advanced Dairy Chemistry, Vol. 1, Proteins, 3rd ed., Kluwer Academic, New York.
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11. Masters, K. 1991. Spray Drying Handbook. 5th ed. Longman, Harlow.
12. Walstra, P. 2003. General aspects of water content and activity, and the effects on food properties and stability: Physical Chemistry of Foods, Dekker, New York.
13. http://www.niro.com/NIRO/

Dairy By-Product Technology 3 (2+1)

Objective

- To develop skills to process dairy byproducts to manufacture value added products

Theory

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems, Physico-chemical characteristics of whey, butter milk and ghee residue

By-products from skim milk: (a)Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. (b) Industrial and food uses of caseins (c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications. (d) Manufacture of casein hydrolysates and its industrial application. (e) Co-precipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications.

Whey processing: (a) Fermented products from whey, (b) Beverages from whey, (c) Deproteinized and demineralized whey, (d) Condensed whey, (e) Dried whey, types and their specification, manufacturing techniques, (f) Utilization of whey products. Application of membrane processing for whey processing.

Whey protein concentrates: (a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates, (b) Functional properties and food applications of WPC.

Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: (a) Condensed butter milk, (b) Dried butter milk, (c) Utilization of butter milk products.

Ghee residue: Composition, processing and utilization. Nutritional characteristics of by-products.

Practical

Manufacture of edible casein from cow and buffalo milk; Manufacture of rennet casein; Manufacture of sodium caseinate; Manufacture of calcium caseinate; Manufacture of co-precipitate; Isolation of whey proteins by cold precipitation technique; Manufacture of whey proteins, concentration by ultra filtration process; Manufacture of whey drinks; Manufacture of dried whey; Manufacture of lactose; Incorporation of whey protein concentrates in processed cheese foods; Manufacture of coffee whitener.

Suggested reading

1. Caric, M. 1994. Concentrated and Dried Dairy Products. VCH Publishers, Inc., New York.
2. Fox, P.F. (Ed.) .1992. Advanced Dairy Chemistry. Vol.1: Proteins, 3rd ed. Elsevier Applied Science, London.
3. Fox, P.F. and McSweeney, P.L.H. 2003. Advanced Dairy Chemistry. 3rd ed. Vol.1, part B. Kluwer Academic/Plenum Publishers, New York.
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8. Southward, C.R. 1985. Manufacture and application of edible casein products 1. Manufacture and properties. New Zealand Journal of Dairy Science and Technology, 20: 79-101.
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10. Webb, B.H. and Whittier, E. O. 1970. By-products from Milk. 2nd ed. AVI Publishing Company, Inc., Westport (Connecticut), USA.
11. Zadow, J. G. 1992. Whey and Lactose Processing. Elsevier Applied Science, London.

Quality and Safety Monitoring in Dairy Industry 3 (2+1)

Objectives

1. Learn about the domestic and global food safety standards and regulations that are in place to ensure microbial safety of dairy foods
2. Develop understanding of principles and concept of food safety management system for adequately implementing strategy to control critical points and prevent hazard
3. Understand concepts of microbiological risk analysis and learn handling of dairy pathogens
4. Learn rapid enumeration techniques for indicator organisms critical from the perspective of plant and equipment hygiene

Theory

Concepts of Quality: Quality as defined by various authors and organizations, History of Quality, Seven tools of quality, Quality Assurance vs. Quality Control, Total Quality Management

(TQM); Concepts of Quality Management System (QMS)–ISO: 9001:2015; Principles of QMS; Standard requirements for QMS. Concept of Six sigma and lean sigma. Kaizen; Toyota Production System (TPS).

Global quality and food safety standards, Role and activities of International organizations involved in food regulation (CAC, WHO, FAO, INFOSAN, FDA, EFSA, ICMSF, GFSI, ISO etc.). Codex Alimentarius Commission (CAC): Working, History of CAC- GATT-Uruguay Round, WTO Regime, Sanitary and Phytosanitary (SPS) Standards, CAC in International food trade. National Organizations involved in food safety and quality (FSSAI, BIS, Agmark), FSSAI: Mandate, Role, Activities, Online services (FLRS, InFOLeT), Integrated food law, its main features and functions. Integrated food law of India (FSS 2006).

Food Safety: Good Manufacturing Practices (GMPs and cGMPs) and Good Hygienic Practices (GHPs); Pre-requisite programs (PRPs); HACCP: history, concept, principles and steps, with special reference to biological hazards in dairy foods, Concept of Food safety management system (FSMS)- ISO 22000:2018, principles and requirements; FSSC 22000; Comparison of ISO 22000 and FSSC 22000. Food safety auditing.

Microbiological Risk Analysis Concepts: Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria (Standards, Guidelines and Specifications), ICMSF two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant.

Tests and Microorganisms in process hygiene criteria and food safety criteria for dairy products as per FSSAI. Enumeration principles and procedure for conventional and rapid detection of predominant hygiene indicator organisms; Conventional and rapid techniques for isolation and identification of safety indicator organisms like *E. coli* (*E.coli*0157:H7), *Salmonella, Shigella, Bacillus cereus*, Sulphite reducing Clostridium and *Listeria monocytogenes*.

Plant and equipment hygiene: Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.

Practical

Conventional techniques for evaluation of milk and milk products for Hygiene and safety. Rapid detection of pathogenic bacteria based on antigen antibody principle: *Staphylococcal enterotoxins, E. coli* O157:H7*, Listeria monocytogenes* and *Salmonella* using VIDAS system; Rapid detection of total plate count, yeast and mold counts, Coliform, *E. coli*, Enterococci, Enterobacteriacae count using D-count and 3M Petrifilm kits; Preparation of GMP/GHP report; Designing of HACCP plan for milk products; Making of Decision Tree for Critical Control Point (CCP) determination; Prepration of audit report for ISO 9001 and ISO 22000; Evaluation of common sanitizing agents used in dairy plants by (a) suspension, (b) capacity test; Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods; Determination of BOD in dairy waste water.

Suggested reading

1. Bramley, A. J., McKinnon, C.H. 1990. The Microbiology of Raw Milk. In: Robinson, R.K. (Ed). Dairy Microbiology, Vol. 1., Elsevier Science Publishers, London.

2. Deeth, H. C., Datta, N. 2003 Heating systems - Ultrahigh temperature treatment (UHT). Encyclopedia of Dairy Sciences, Roginski, H., Fuquay, J.W., and Fox, (P.F. Eds). Elsevier Science Ltd, London, pp2642-2652.
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4. Hersom, A. C., Hulland, E. D. 1980. Canned Foods - Thermal Processing and Microbiology. Churchill Livingstone, Edinburgh.
5. Hinriches, J., Rademacher, B. 2003. Sterilization of milk and other products. Encyclopedia of Dairy Sciences. Roginski, H., Fuquay, J.W., and Fox, (P.F. Eds). Elsevier Science, London, pp. 2569-2577.
6. ICMSF [International Commission on Microbiological Specifications for Foods] .2002. Microorganisms in Foods 7: Microbiological testing in food safety management. Kluwer Academic/Plenum Publishers, New York.
7. ICMSF. 1998. Micro-organisms in Food 6: Microbial Ecology of Food Commodities. Blackie Academic & Professional, London.
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9. ICMSF. 2002. Microorganisms in Foods 7. Microbiological testing in food safety management. Kluwer Academic / Plenum Publishers, New York, USA.
10. Nieuwenhuijse, J.A. 2003a. Concentrated milk products - evaporated milk. Encyclopedia of Dairy Science. Roginski, H., Fuquay, J.W., and Fox, P.F. (Eds). Elsevier Science, London, pp. 493-499.
11. Nieuwenhuijse, J.A. 2003b. Concentrated milk products - sweetened condensed milk. In: Encyclopedia of Dairy Sciences. Roginski, H., Fuquay, J. W., and Fox, P. F. (Eds). Elsevier Science, London, pp. 499-503.
12. Sutherland, B.J. (2003) Saltignfo cheese. Encyclopedia of dairy sciences. Elsevier Science, In: Roginski, H., Fuquay, J.W., and Fox, P.F. (Eds). London, pp. 293-300.
13. Varnam, A.H. and Sutherland, J.P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology, Vol. I, Food Products Series. Chapman and Hall, London.
14. Will, M. and Guenther, D. 2007. Food Quality and Safety Standards as required by EU Law and the Private Industry. A Practitioners' Reference Book. 2nd Edition. TechnischeZusammenarbeit (GTZ) GmbH. Postfach 5180, 65726 Eschborn, Germany.

Chemical Quality Assurance 2 (1+1)

Objectives

1. To understand regulatory framework, standards and test methods for ensuring chemical quality assurance of dairy products
2. Study national and global regulatory systems in place for ensuring chemical quality of milk and milk products
3. Learn about requirements for setting up of analytical laboratories and its accreditation
4. Develop skills for standardization of reagents and test procedures and calibration of glasswares for determination of quality parameters

5. Learn about possible chemical contaminants in milk and the test procedures to determine their presence in milk and milk products

Theory

Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc.

Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products.

Sampling procedures; labelling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer.

Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods.

Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf-life behavior of milk and milk products.

Practical

Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Detection of vegetable oils and animal body fat adulteration in ghee. Analysis of market samples of milk and milk products. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

Suggested reading

1. Alli, I. (2004). Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, USA.
2. Armit, E.G. (1975). Protein testing in the dairy laboratory. J. Soc. Dairy Technol., 28 (4) 189-191.
3. Biggs, D.A., Johnson. G. and Sjaunja, L.O. (1987). Analysis of fat, protein, lactose and total solids by infrared absorption. IDF Bull., No. 208, 21-29.
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6. Desraj. (2007). Estimation major milk constituents using autoanalyser. Winter School on Instrumental Analysis of Dairy Food for Quality Standards, July 6th to July 26th, 2007, NDRI, Karnal.

7. Herschdoerfer, S.M. (2004). Quality Control in the Food Industry. Vol. I & II. Academic Press, London.
8. IDF. (1991). Residues and Contaminants in Milk and Milk Products. Special Issue. Int. Dairy Fed., Brussels.
9. IDF .(1991). Detection and confirmation of inhibitors in milk and milk products. IDF Bulletin No. 258.
10. IDF. (1997). Monograph on Residues and Contaminants in Milk and Milk Products. Special Issue. Int. Dairy Fed., Brussels.
11. Jacobs, M.B. (1999). Chemical Analysis of Food and Food Products. CBS Distributors, New Delhi.
12. Kilcast, D. and Subramaniam, P. (2000). The stability and shelf-life of food. Woodhead Publishing Ltd., Cambridge, England.
13. Kramer, A. and Twigg, B.A. (Eds) .(1966). Fundamentals of Quality Control for the food industry, The AVI Publ. Co., West Port, Conn., USA.
14. Rangappa, K.S and Achaya, K.T. (1974). "Indian Dairy Products". 2nd ed. Asia Publishing House, Mumbai.
15. Sen, D.C. and Roy, N.K. (1994). A Text Book of Practical Dairy Chemistry.
16. Van Resusel, A. and Klign, C.J. (1987). Automated methods for routine analysis of raw milk. The dye binding method for determination of the protein content of milk. IDF Bull No. 208, 17-20.

Instrumentation and process control 3 (2+1)

Objective

To study important instruments used in dairy processing operations and learn how to control the processes using these instruments

Theory

Importance of instrumentation and process automation in Dairy process control, Instrumentation scheme and characteristics: Introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems.

Sensors: Definition, principle of sensing and transduction, classification, selection and applications of Sensors. Types of Sensors, Measurement of parameters Proximity sensors: applications in Dairy processing operations, Digital and analogue signals, handling and processing, Piezo electric sensor: construction- working and applications, Micro, Nano sensors and smart sensors: Construction, characteristics and applications. Switches: Relays, solid state relay, Contactors etc, Micro and Limit switches: Types, construction, working and applications.

Electric Power Monitoring and control: Measurement and control of electric Power, digital AC/DC Volt, current, frequency PF meters. Voltage protection, Earth leakage, current protection, Phase reversal, phases monitoring relays. PF control relays, Smart Energy meters: Role and importance. Solid state alarm: working and application in dairy processing. Valve automation: Different types of automation valves and their application, Variable frequency drives (INVERTER): Importance, types, Construction, working and their application in Dairy process automation.

Speed control of DC motors. Digital Process timers: On-delay, Interval, cyclic, sequential, reverse-forward, star delta, totaliser and counter types of timers, their applications in control of dairy process operation. Micro-processor and Micro-controllers: Introduction and application.

Data acquisition and data loggers: Importance- and applications, Programmable logic controller: Introduction, importance, working- selection and applications, Communication Interfaces: RS-485, Rs-232, modbusetc, their role and applications, Programmable touch screen and HMI: Introduction, importance, working- selection and usage, SCADA: Introduction, importance, working- selection and usage.

Electronic Instruments: Role and importance of general purpose test instruments, Electronic Millimeter, Cathode Ray Oscilloscope, Measurement of amplitude, frequency and phase using CRO Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Display devices and recorders like X-Y and X-T recorders. Automation: Introduction to plant automation, automation hierarchy, PLC, SCADA.

Practical

Strain gauge characteristics and weight measurement; Measurement of pressure using bellows and diaphragm; Fabrication and calibration of thermocouples; Study the construction and working of Bourdon pressure gauge; Testing and calibration of pressure gauges using dead weight tester; Study the mechanism of pH meter and calibration; Study of proximity sensor; Study of different parts and working of pressure switch.

Study of RTD and Thermister; Study of different speed measurement sensor/ instruments; Study of LVDT; Measurement of level and flow using controllers; Temperature control using PID and On/Off controllers; Generation of wave signals using CRO, Data acquisition to PC from instruments using RS232/485 and USB interfaces, Fabrication of micro sensors and Study of PLC systems and Demonstration of PLC systems in Dairy Plant.

Suggested reading

1. Bela G, Liptak. 2003. Instrument Engineer's Handbook. Vol. I and II. 4th Ed. CRC Press. Boca Raton. FL, USA.
2. Doebelin, E.O. 2003. Measurement systems – Application and Design. Tata McGraw-Hill, New Delhi.
3. Don W, Green and Robert H, Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Gupta, J. B. 2003. A course in Electronic and Electrical Measurements. S. K. Kataria and Sons, New Delhi.
5. Johnson, C. D. 1977. Process control instrumentation technology. John Wiley & Sons. New York
6. Moorthy, D. V. S. 2003. Transducers and instrumentation. Prentice Hall of India Pvt. Ltd.
7. Rajput, R. K. 2006. Mechanical Measurements and Instrumentation. S. K. Kataria& Sons, New Delhi.
8. Theraja, B. L. 2008. A Text Book of Electrical Technology. S. Chand & Co., Ltd, Delhi.

Dairy Process Engineering 3 (2+1)

Objectives

1. To enable students understand working principles and design of equipments involved in concentration and drying of milk, mechanized manufacture of traditional Indian dairy products and packaging of milk
2. Learn about heat transfer, mass and energy balance and material transport involved in concentration and drying of milk
3. Understand design and operation of evaporators, dryers and fluidizers used for milk processing plants
4. Acquire knowledge of various membrane processing systems suitable for processing of milk and whey
5. Understand design and operation of packaging systems for milk, mechanized manufacture of Indigenous dairy products, frozen desserts and cheese

Theory

Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators.

Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems; Factors affecting bulk density of powder, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers.

Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers.

Processing equipment: Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipment; Packaging equipment: Packaging machines for milk and milk products.

Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

Practical

Constructional details, operation and maintenance of Vacuum pan; Constructional details, operation and maintenance of multiple effect evaporator; Constructional details, operation and maintenance of spray drier; Constructional details, operation and maintenance of butter making equipment; Constructional details, operation and maintenance of equipment related to ghee production; Constructional details, operation and maintenance of ice-cream making equipment; Constructional details, operation and maintenance of cheese making equipment; Constructional

details, operation and maintenance of reverse osmosis and ultra filtration system; Design problems on double effect evaporator and vacuum pan; Visit to a milk product plant.

Suggested reading

1. Ahmed, T. 1985. Dairy Plant System Engineering. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
2. Ahmed, T. 1990. Dairy Plant System Engineering and Management. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
3. Anantakrishnan, C.P. and Simha, N. N. 1987. Technology and Engineering of Dairy Plant Operations. Laxmi Publ., Delhi.
4. Brennan. 1969. Food Engineering Operations. Elsevier Publ. Co., Amsterdam, New York.
5. Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
6. Gardner, A. W. 1971. Industrial drying. Leonard Hill Publ., London.
7. Kesseler. 1981. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.
8. Masters, K. 1972. Spray drying: an introduction to principles, operational practice, and applications. Leonard Hill Publ., London.
9. Robinson, R. K. 1993. Modern Dairy Technology. Chapman & Hall, UK.
10. Spicer, A. 1974. Advances in Pre-concentration and Dehydration of Foods. John Wiley & Sons. New York.

Operations Research 2 (1+1)

Objective

To make students understand and analyse managerial problems and use optimization techniques to find solutions for using resources more effectively

Theory

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making; Modelling in Operation Research; Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems.

Inventory Control – Introduction and general notations, Economic lot size models with known demand; Replacement – Introduction, Replacement of items whose efficiency deteriorates with time.

Queuing – Introduction and general notions, Classification of queues and their problems, Probability distribution of queues; Various models in the queuing system; Sequencing – Statement of the problem, notations and assumptions, Problems with 'n' jobs and two machines; Generalization to 'm' machines.

Transportation model – Definition and application of transportation model, Formulation of transportation problems and their solutions; Assignment problems and their solutions.

Framework of PERT and CPM, Activities, events and network, PERT and activity time estimates, probability of project completion critical path analysis.

Practical

LP problems; Inventory Control problems; Replacement model problems; Problems on queuing theory, sequencing, transportation, assignment; PERT/CPM.

Suggested reading

1. Churchman, C.W., Ackoff R. L. and Arnoff, E.L. 1957. Introduction to Operations Research. John Wiley and Sons, New York.
2. Goel, B.S. and Mittal, S.K. 1974. Operations Research. Pragati Prakashan, Meerut.
3. Kapoor, V.K. and Kapoor, S. 2001. Operations Research Techniques for Management. Sultan Chand and Sons, New Delhi.
4. Sasieni, M.A., Yaspan and Friedman, L. 1959. Operations Research: Methods and Problems. John Wiley and Sons, New York.
5. Sharma, S.D. 1999. Operations Research. Kedar Nath Ram Nath & Co., Meerut.
6. Swarup, K., Gupta, P.K. and Mohan, M. 1989. Operations Research. Sultan Chand and Sons, New Delhi.
7. Taha, H. A. 2003. Operations Research. 7th edm. Pearson Education, New Delhi.
8. Taha, H.A. 2005. Operations Research: An Introduction. Prentice Hall of India Private Limited, New Delhi.
9. Wagner, H.M. 1982. Principles of Operations Research, with Applications to Management Decisions. Prentice Hall of India, New Delhi.

Economic Analysis 2 (2+0)

Objective

To equip students with the knowledge of analytical skills necessary to analyze economic phenomena, make informed decisions and apply economic principles to real-world situations

Theory

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors.

Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus.

Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns.

Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale.

Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition; National income – GDP, GNP, NNP, disposable personal Income, per capita income, inflation.

Suggested reading

1. Ghai, P. and Gupta, A. 2002. Microeconomics Theory and Applications. Sarup and Sons Publ., New Delhi.
2. Henderson, J.M. and Quandt, R.E. 2000. Microeconomic Theory: A Mathematical Approach. Mc-Graw Hill Kogakusha Ltd., Tokio.
3. Kreps, D.M. 1990. A Course in Microeconomic Theory. Princeton University Press, Princeton.
4. McAfee, R. P. and Johnson, J. S. 2005. Introduction to Economic Analysis.University Press Publ., Florida.
5. Rittenberg, L. and Tregarthen, T. 2009. Principles of Microeconomics. Flat World Knowledge, New York.
6. Samuelson, P. and Nordhaus, W. 2010. Economics. 17th edn. Tata Mc-Graw Hill, New Delhi.

SEMESTER-VI

Dairy Plant Management and Pollution Control 2(1+1)

Objective

The primary objective of the course is to provide students with comprehensive knowledge and skills related to the management of dairy processing operations and the effective control of pollution

Theory

Production Management: Definition, Function and structure of Production Management, Production planning and Control, Work study and measurement motion and time study; Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency.

Plant Operations Product and process control, Control charts, Process Sigma, Efficiency factors losses, Financial and Managerial efficiency; Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act and Regulations.

Human Resource Management: Personnel Management, Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions.

Safety hazards: hazards prevention, security for plant machinery and the employees, Plant Maintenance; Prevention and Break-down maintenance: Spare parts inventory, tools and lubricants, etc; Food hygiene: personnel hygiene, plant hygiene, water quality, etc.

Wastes discharged from dairy plants: An overview; Wastewater discharged from (a) Milk reception dock, (b) Liquid milk processing section, (c) Butter and ghee manufacturing, (d) Ice-cream and condensed milk manufacturing, e) Milk powder manufacturing, (f) Cheese and paneer manufacturing; Packaging wastes; CIP cleaning, Environmental issues in effluent discharge: (a) Effects on waterways, (b) Effects on land, (c) Effects on the atmosphere (d) Solid waste.

Waste treatment process in a dairy processing plant: Wastewater treatment options for A Dairy Processing Plant; Calculation of wastes discharged and the economics thereof.

Practical

Flow process charts of different milk products; Identification of steps of material losses on dairy plants; Identification of hazardous processes and equipment, (HACCPT plan) safety and precautions; Identification and uses of common lubricants; Waste characterization and Waste Utilization processes; Various treatments in waste disposal; Analysis of cleaning agents and sanitizers; Reports and records maintenance of dairy plant; Operational precautions; CIP cleaning.

Suggested reading

1. David, J. 2007. Contemporary Trends in Dairy Plant Management. Gyan Books Pvt. Ltd., Delhi
2. Kumar, H.D. 1998. Environmental Pollution and Waste Management. MD Publ. Pvt. Ltd., New Delhi.
3. Maliwal, G.L. 2007. Hand book of Environmental Management. Agrotech Publ. Academy, India.
4. Warner, J. N. 1976. Principles of Dairy Processing. John Wiley Publ., New York.

Strength of Materials and Dairy Machine Design 3 (2+1)

Objective

To enable students to analyze and design dairy machinery and related equipment

Theory

Strength of Materials: Basic concepts in Statics and Dynamics; Force Systems; Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem; Dynamics: Equation of motion.

Translation and rotation of a Rigid body, work and mechanics of materials: Stress-Axial Load Classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio: Shearing Stresses; Torsion, Torsion formula, Angle to Twist of circular members; Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams; Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads.

Dairy Machine Design: Procedures, Specification, strength, design factor, factor of safety selection of factor of safety; Materials and properties; Static strength, ductility, hardness, fatigue, designing for fatigue conditions; Theories of failure, Stresses in elementary machine parts, Design of a drive system; Design of length and thickness of belt.

Bearing: Journal and Anti-friction bearings; Selection of ball, tapered roller and thrust bearing; Springs, helical and leaf springs; Energy stored in springs; Design and selection of springs.

Practical

Design problems on applications of engineering statics and dynamics; Design problems on applications of work and energy; Design problems on applications of linear and angular momentum; Design problems on stress-strain diagram evaluation of elastic constants; Study on shear force and bending moment diagrams and its applications; Design problems on applications of flexural stresses; Design problems on applications of shearing stresses in beams; Study on system of limits, fits and tolerances and their applications; Design stresses in elementary machine parts; Design features and

applications of shafts; Design features and applications of axles; Design features and applications of keys; Design features and applications of couplings.

Design problems on various types of power transmission systems; Design features and applications of bearings; Design features and applications of springs; Design problems on agitator/ stirrer; Design features of milk silo.

Suggested reading

1. Adithan, M. and Bahl, R. Metrology Laboratory Manual. NITTTR, Chandigarh.
2. Bhandari, V. B. 2018. Design of Machine Element (Fourth Edition). McGraw Hill Education.
3. Hall Alfred. Machine Design. by Hall Alfred, McGraw Hill Pub.
4. Jain, R.K. Engineering Metrology by RK Jain. Khanna Publishers, New Delhi;
5. Kumar, S. Ravi. (2017). Principles of Dairy Machine Design. agrimoon.com
6. Rajput, R.K. Engineering Metrology. SK Kataria and Sons, Ludhiana.
7. Sharma, P. A Textbook of Machine Design. Kataria S. K. & Sons.
8. Sharma, P.C. A Text Book of Production Engineering. S Chand and Company, New Delhi.

Financial Management and Cost Accounting 3 (2+1)

Objective

To provide students with a foundational understanding of financial management principles, accounting systems and cost analysis methods

Theory

Introduction: Definition, scope and objectives of financial management; Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting; Doubles entry system of Book-Keeping; Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book; Preparation of Final Accounts and adjustments at the end of trading period; Preparation of Trial Balance Banking Transactions and Bank reconciliation statements; Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making.

Financial Analysis: Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis; Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis; Capital Structure: C;S Planning, risk return trade off, financial leverage; Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital and retained earnings, overall cost of capital.

Investment decision: Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Pay-back period method, Accounting rate of return method; Capital budgeting: Complex Investment Decisions: Investment timing and duration Investment decisions under inflation, Investment decisions under capital rationing.

Project Report; Feasibility Report Valuation; Working capital management- Concept and determinants of working capital, Estimating working capital needs; Depreciation – Concept and method; Introduction, Definition, Objectives, Common terms.

Costing: Essentials of sound costing system; Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium and Bonus Plans, Materials, Overheads.

Cost classification: Direct and Indirect expenses, fixed and variable costs; Various methods of apportioning indirect expenses; Inventory Management: Planning, control and costing; Stores and storekeeping, scope and importance, purchase procedure, types of purchase, location of stores and materials, procedure for the movement of stores, different methods of pricing materials, store records; Cost Sheets-Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations; Contract or Terminal costing; Process Costing: Process losses and inter-process profits, joint products and by products costing; Ascertainment of cost of milk production; Preparation of Cost Account Information for managerial decisions.

Practical

Preparation of Profit and Loss account; Preparation of Balance Sheet; Preparation of Cash flow statements; Preparation of Funds flow statements; Problems on Ratio analysis; Problems on Break-Even Analysis; Problems on Profit analysis; Problems on Operating Analysis; Problems on Financial leverage; Problems on Cost of Capital; Problems on Investment decisions; Problems on Capital budgeting.

Suggested reading

1. Bhattacharyya. 2007. Essential of Financial Accounting. S. Chand and Co., New Delhi.
2. Gupta, S.K. and Sharma, R.K.1996. Financial Management: Theory and Practice. Kalyani Publ., Ludhiana.
3. Khan, M.Y. and Jain, P. K. 2011. Financial Management: Text, Problems and Cases. Tata Mc Graw-Hill Publ., New Delhi.
4. Maheswari, S.N. 2010. Management Accounting and Financial Control. Sultan Chand and Sons, New Delhi.
5. Pandey, I.M. 1989. Financial Management. Vikas Publ., New Delhi.
6. Pandey, I.M. 2006. A Management Guide for Managing Company Funds and Profits. Tata Mc Graw-Hill Publ., New Delhi.
7. Reddy, P.N. and Appaniah, H.R. 1997. Essential of Management Accounting. Himalaya House, Bombay.
8. Shukla, M.C. and Grewal, T.S. 1979. Advanced Accounts. S. Chand and Co., New Delhi.

Food and Industrial Microbiology 2 (1+1)

Objective

The first part of the course deals with microbiological aspects of various food products including their spoilage and preservation technologies; The latter part deals with industrial fermentation and product manufacturing.

Theory

Scope of food microbiology: Basic aspects, history and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in different foods; Microbial Spoilage of foods: Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; Sources of contamination; Control of spoilage.

Food preservation: Principles of food preservation: physical methods, viz. low temperature and high temperature preservation (D, Z and F Values); Drying Methods; Chemical preservatives, Natural antimicrobial compounds and bio- preservation; Alternate methods of food preservation; Mode of action of various preservation methods on microbes.

Fermentation processes: Fermentation processes: Historical development, the range, components and types (i.e., submerged, surface and solid-state fermentation); criteria for selection of industrially important microorganisms; preservation and improvement of industrially important micro-organisms using metabolic engineering/genetic engineering; media for industrial process; upstream and downstream processing.

Types of fermenters: Fermenters: types (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis, estimation of biomass; difference in chemostat and turbidostat.

Microbial production of industrial products: Immobilization of enzymes/cells; Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine; organic acids (citric and lactic), enzymes (protease, lipase and rennet), vitamin (B_{12}), antibiotics and bacteriocins; and fermented whey beverages.

Practical

Microbiological examination of: (1) fresh and canned fruits, vegetables and juices; (2) flour and bread; and (3) eggs and meat; Isolation of psychrophilic, salt and sugar tolerant microorganisms from foods; Isolation of industrially important microorganisms from environment; Determination of Z, D and F values; Production and assaying of microbial enzymes (protease/ lipase); Production of lactic acid from whey; Production of nisin and assaying the antimicrobial activity of the culture; Design and control of a table-top and 10 liter lab fermenter (Demonstration); Production of ethyl alcohol from molasses and whey by yeasts; Production of fermented whey beverages; Educational tour to food processing/ fermentation industries.

Suggested reading

1. Adams, M.R. and Moss, M.O. 2002. Food Microbiology. 2nd edn. Panima publ., New Delhi.
2. Doyle, M.P., Beuchat, L.R. and Montville, T.J. (Ed.). 2001. Food Microbiology: Fundamentals and Frontiers. 2nd edn. ASM Press, Washington, D.C. USA.
3. Frazier, W.C. and Westhoff, D. C. 2004. Food Microbiology. 3rd edn. McGraw-Hill, New Delhi.
4. Jay, J. M. 1992. Modern Food Microbiology. 4th edn. Van Nostrand Reinhold, New York, USA.
5. Labuza, T.P., Fu, B., and Taoukis, P.S. 1992. Prediction of shelf life and safety of minimally processed CAP/MAP chilled foods: a review. J. Food Prot., 55,741.
6. Montville, T.J. and Matthews, K.R. 2005. Food Microbiology-An Introduction, ASM Press, Washington, D.C. USA.

7. Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Enfield: Science Publ., USA.
8. Puniya AK. 2015 Fermented Milk & Dairy Products. CRC Press /Taylor & Francis (ISBN-9781466577978). pp 1-714.
9. Ray, B. 2004, Fundamental Food Microbiology 3rd edn., CRC Press, Washington D.C. USA.
10. Reed, G. (Ed.).1987. Prescott and Dunn's Industrial Microbiology. 4th edn. CBS Publ., and Distributors, Delhi, India.
11. Waites, M. J. 2001. Industrial Microbiology: An Introduction. Blackwell Science, London.

Packaging of Dairy Products 2 (1+1)

Objective

To learn about the packaging materials and packaging systems available for milk and different types of milk products

Theory

Introduction, Importance of Packaging, History of Package Development, packaging materials, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information.

Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeats, concentrated and dried milks including baby foods; Packaging of functional dairy/food products.

Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages.

Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipment (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials.

Disposal of waste package materials, Packaging Systems; Hazards from packaging materials in food.

Practical

Identification of packaging materials, Flame Hot wire test, Testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength; Testing of glass bottle – resistance to thermal shock; Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance; Packaging of different dairy products by using prepack and vacuum packaging machines.

Suggested readings

1. Ahvenainen, R. (2003). Novel Food Packaging Techniques. Woodhead Publ. Ltd., Cambridge, England.

2. Bekker, M. (Ed.). (1986). Wiley Encyclopedia of Packaging Technology. John Wiley and Sons. New York.
3. Coles, R., Mc Dowell, D. and Kirwan, M. J. (2003). Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK.
4. Engineers India Research Institute. (2005). Handbook of Packaging Technology. EIRI, Delhi.
5. Han, J. (2005). Innovations in Food Packaging. Elsevier Science & Technology Books.
6. Hintlian, C. B. and Hotchkiss, J.H. (1986). The Safety of Modified Atmosphere Packaging: A Review, Food Technol. 40(12): 70–76.
7. Piringer, O. G. and Baner, A. L. (Ed.). (2008). Plastic Packaging: Interaction with Food and Pharmaceuticals. John Wiley and Sons, Weinheim, Germany.
8. Yam, K. L. (2009). Encyclopedia of Packaging Technology. 3rd edn. John Wiley and Sons, Inc. Publ., USA.

Food Technology-I **3 (2+1)**

Objective

To provide students with an in-depth understanding of food processing techniques as applied to fruits, vegetable and other plant based products

Theory

Harvesting, transportation and storage of fruits and vegetables; Post harvest processing of fruits and vegetables: Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables.

Juice processing: General steps in juice processing, role of enzymes in fruit; Juice extraction, equipment and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders; Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices.

Manufacture of Jam, Jelly and Marmalade: Role played by pectin, sugar and acid in jellied fruit products; Fruits and vegetable preserves, Glazed, Crystallized fruits; Tomato based products: Juice, puree, paste, sauce, ketchup; Pickles: Principle of pickling, technology of pickles.

Beverages: Classification, scope, carbonated non-alcoholic beverages and their manufacture; Fruit beverages and drinks, additives for fruit based beverages; Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee; Tea: Tea leaf processing, green, red, yellow, instant tea.

Technology of confectionery foods: Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products; Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products; Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

Practical

Manufacture of toffees and caramels, Testing the efficacy of blanching process; Drying of fruits and vegetables; Preparation of fruit-based drinks and beverages: Ready-to-serve drink,

Nectar, Squash, Whey-fruit based beverages; Manufacture of fruit jam; Manufacture of fruit jelly; Manufacture of chocolate confections; Manufacture of tomato ketchup/tomato sauce; Manufacture of soups; Manufacture of fruit preserve; Manufacture of candied fruits; Manufacture of fruit bar; Manufacture of pickles.

Suggested reading

1. Beckett, S. T. (1999). Industrial Chocolate, Manufacture and Use. Blackwell Science Ltd., Maldon, USA.
2. Edwards, W. P. (2000). The Science of Sugar Confectionery. The Royal Society of Chemistry, Cambridge, UK.
3. Er. B. Pantastico. (1975). Post Harvest physiology, handling, and utilization of tropical and sub-troipcal fruits and vegetables. AVI Publishing Co. Westport Conne.
4. Fellows, P. J. (2009). Food Processing Technology: Principles and Practice. 3rd Edition. CRC Woodhead Publishing, Boca Raton (USA).
5. Goldberg, Israel. (1994). Functional Foods: Designer Foods, Pharma Foods, Nutraceuticals. Aspen Publications, Maryland.
6. Hui, Y. H. (2006). Handbook of Food Science, Technology and Engineering. CRC Taylor & Francis Group, Boca Raton, FL, USA.
7. Jackson, E. B. (1990). Sugar Confectionery and Manufacture. Blackie and Son Ltd., Glasgow, NZ.
8. Laura A. de la Rosa, Emilio Alvarez-Passilla and Gustavo, A. Gonzalez-Aguilera. (2010). Fruits and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability. Willey Balckwell Publisher, Iowa (USA).
9. Somogyi, L.P., Ramaswamy, H. S. and Hui, Y. H. (1996). Processing Fruits: Science & Technology. Biology, Principles and applications, Vol.1. Technomic Publ. Co. Inc, Lancaster, USA.
10. Thompson, A. (2010). Controlled Atmosphere Storage of Fruits and Vegetables. 2nd Edition. CAB International, Oxfordshire, UK.
11. Vernam, A. H., and Sutherland, J. P. (1999). Beverages: Technology, Chemistry and Microbiology, Vol.2. Aspen Publ., Maryland.

Food Chemistry 3 (2+1)

Objective

To provide students with a comprehensive understanding of the chemical composition and properties of food systems and constituents

Theory

Water: Water binding and chemical reaction mediated by water; Food proteins: Classification and physico-chemical and structural properties; Lipids: Definition, classification of lipids, Unsaponifiable matter contents in various fats and oils, classification and chemical composition.

Carbohydrates: Classification of carbohydrates, polysaccharides, viz. linear, branched and modified; Properties and utilization of common polysaccharides, viz. cellulose, glycogen,

hemicelluloses, pectin; Food Enzymes: Hydrolases and lipases, utilization in food chemistry; Minerals in foods: Main elements, trace elements in eggs, cereals and cereal products, vegetables and fruits; Aroma compounds in foods: Threshold value, off-flavours.

Food additives: Vitamins and Amino acids, Minerals, Aroma Substances/flavour enhancers-Monosodium glutamate, 5-nucleotides sugar substitutes, sorbitol sweeteners- saccharin, and cyclamate, Food colours and food preservatives.

Antinutritional factors and Food contaminants: Toxic trace elements, radio nucleotides; Cereal and cereal products: Individual constituents like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making, influence of additives /minor ingredients on baking properties: physico-chemical changes during baking; Legumes: Classification, general composition and physico-chemical properties.

Vegetables and Fruits: Classification, general composition, chemical changes during ripening and storage; Jams, Jellies and Pickles: Classification, composition and preservation; Preservation of foods, general principles of food preservation.

Practical

Determination of moisture, acidity and gluten content in flour; Determination of total ash and acid insoluble ash in flour; Determination of starch in flour; Determination of total nitrogen in cereal products; Determination of acidity and vitamin C in citrus fruits; Analysis of tomato ketchup for total solids, acidity, ash and salt; Determination of total sugar in tomato ketchup; Determination of total ash and alkalinity of soluble ash in tea; Determination of water extractive in tea leaves. Determination of presence of Chicory in coffee powder; Determination of reducing sugars in Jam; Determination of iron in infant foods.

Suggested reading

1. Aurand, L. W. and Wood, A. E. (1973). Food Chemistry. The AVI Publishing Co., Connecticut.
2. Belitz, H. D., Grosch, W. and Schieberler, P. (2004). Food Chemistry. Springer, Berlin.
3. DeMan, J. M. (1999). Principles of Food Chemistry. A Chapman and Hall Food Science Book, Aspen Publ., Inc., Gaithersburg, Maryland.
4. Fennama, O. R. (ed). (1996). Food Chemistry. Marcel Dekker, Inc., New York.
5. Gopalan, C., Rama Sastri, B.V., and Balasubramaniam, S.C. (1991). Nutritive value of Indian Foods. National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR), Hyderabad.
6. Meyer, L. H. (1976). Food Chemistry. Reinhold Publ. Corporation, New York.
7. Potter, N. M. (1995). Food Science. The AVI Publishing Co., Connecticut.

Energy Conservation and Management 2 (1+1)

Objective

To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries

Theory

Introduction: Potential and Importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act 2003, Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution.

Energy balances and computation of efficiencies of equipment; Role of Energy inspectors and Auditors in energy management; Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques; Quality of power, Power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motor-selection and application, Energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls.

Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings.

Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors; Maintenance and upkeep of Vacuum lines and Compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment.

Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator.

Energy conservation in buildings: Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits.

Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries; Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of Energy Balance in Unit Operations and System boundaries; Solving examples on energy balances; Solving

problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve.

Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different BEE Star Ratings; Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Suggested reading

1. Ahmand, Tufail. 2012. Dairy Plant Engineering and Management. Kitab Mahal Publisher.
2. JiřiKlemeš, Robin Smith and Jin-Kuk Kim. 2008. Handbook of Water and Energy Management in Food Processing. A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition
3. Paul O'Callaghan. 1993. Energy Management, McGraw- Hill Book Company Europe, Shppenhangers Road, England.
4. Wang, Lijun. 2008. Energy Efficiency and Management in Food Processing Facilities. CRC Press Inc. 1st edn (4 December 2008). Taylor & Francis.

SEMESTER-VII

S. No.	Course Title	Credit Hours
1.	Food Engineering	3 (2+1)
2.	Dairy Plant Design and Layout	2 (1+1)
3.	Food Technology-II	3 (2+1)
4.	Sensory Evaluation of Dairy Products	2 (1+1)
5.	Biochemistry and Human Nutrition	2 (1+1)
6.	Elective Courses	**8*** **
	Total	**20**
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses should be opted to complete total 20 credits)		

Food Engineering 3 (2+1)

Objective

To provide a strong foundation in understanding the physical and mechanical properties of food and various unit operations in food processing.

Theory

Rheology: Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of

solids foods, Viscoelastic models; Measurement of food texture; Food Freezing: Thermal properties of frozen foods; Predication of freezing rates; Plank's equation, Design of food freezing equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods.

Food dehydration: Estimation of drying time for food products, constant rate period and falling rate period dehydration; Diffusion controlled falling rate period; Use of heat and mass balances in analysis of continuous dryers, Principle, construction working of vacuum drier, ring dryer, Flash dryer, fluid bed granulator, tunnel, Rotary dryer, solar dryer; Freeze concentration and dehydration: Heat and mass transfer, Calculation of drying time, Industrial freeze drying.

Other advance food processing operations and equipment: Equipment for fruit washing, pulping, fruit juice extraction, blanching, de-hulling, milling, Juice concentration, aroma recovery and distillation; Handling and storage of fresh produce like fruits and vegetables: Pre-cooling (Field heat removal), cleaning, grading, sorting, packaging and storage; Study of Stability chambers: Principle, construction and working.

Unit operations in Fruit and vegetable: Processing for production of puree and paste : Washing (Hydraulic flume Rotary washer, sorting and grading, size reduction, blanching, hot/cold break system, De-aerators, Pulpers, turbo extractors, forced circulation evaporators, Tube- in tube type sterilizer- Aseptic filler; Size reduction: Theory and principle, Different size reductions equipment; Unit operations and equipment for production of bakery products: Planetary mixer, sigma mixer, Rotary oven, etc. Unit operations in production of Coffee powder production: Mixer, roaster, size reduction plant, Extraction, concentration and spray drying unit; Rewet method of production of granulated coffee.

Meat and fish processing: Meat mincer, Marinator, sausage maker; Food extruder: Principle construction and working of Single and double screw extruder, Hot and cold extrude for production of ready eat and ready to cook foods.

Practical

To determine physical properties of food product; To determine rheological properties of food product; Determination of rheological parameters of solid and liquid foods by graphical solutions; To study food freezers; To study freeze drier; To determine drying characteristics of food product; To compare various dying methods; To determine juice yield; To compare hot water, steam and vacuum blanching; To study construction and working of aroma /distillation system; To study various size reduction equipment; Study of sifter for size separation; Study of planetary mixer/sigma mixer/ whisker etc; Study of grain mill; Study of microniser/colloid mill for homogenisation, emulsification of viscous products like tomato paste, mayonnaise etc; Visit to cold storage; Visit to food processing plant (bakery, coffee processing, meat processing, cereal processing).

Suggested reading

1. Brennan.1969. Food Engineering Operations. Elsevier Publ. Co., Amsterdam, New York.
2. Heldman, D. R. and Singh, R. P. 1981. Food Process Engineering, Avi Pub. Co., Westport, Connecticut.
3. Kesseler. 1981. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.
4. McCabe, W. L. and Smith, J.C. 2005. Unit Operations in Chemical Engineering. McGraw-Hill, New York.

5. Prasad, M. 2005. Refrigeration and Airconditioning. New Age International (P) Ltd., Publ., New Delhi.

Dairy Plant Design and Layout 2 (1+1)

Objective

To equip students with the knowledge and skills necessary to design and plan dairy processing plants efficiently and hygienically

Theory

Introduction of Dairy Plant design and layout: Type of dairies, perishable nature of milk, reception flexibility; Classification of dairy plants, Location of plant, location problems, selection of site; Hygienic design considerations for dairy processing plants;

Planning: Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout; Space requirements for dairy plants, estimation of service requirements including peak load consideration.

Dairy plant design aspects: General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design; Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop; Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility; Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout.

Building construction materials: Floors, general requirement of dairy floor finishes, floors for different section of dairy; Foundations, walls doors and windows.

Other design aspects: Drains and drain layout for small and large dairies; Ventilation, fly control, mold prevention, illumination in dairy plants; Computer aided Design: Introduction to CAD software.

Practical

Building symbols and convention; Symbols for equipment; Study of process schedule; To draw layout of collection/chilling centre; Visit to dairy processing plant for understanding of layout of different sections.

To draw layout of small dairy plant; To draw layout of small dairy plant using CAD; To draw layout of medium dairy plant; To draw layout of large dairy plant; To draw layout of cheese plant; To draw layout of ice-cream plant; To draw layout of butter manufacturing unit; To draw layout of ghee plant; To draw layout of composite dairy plant.

Suggested reading

1. Chander, L. 2004. Dairy Plant Layout and Design. Directorate of Information and Publ. of Agriculture ICAR.
2. Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
3. Hall, H. S. and Blombergsson, H. 1963. Milk Plant Layout. Food and Agriculture Organization Publ. United Nations.
4. Moore, J. M. 1962. Plant Layout & Design. Macmillan Publ., USA.

Food Technology 3 2+1)

Objective

To provide students with a understanding of the processing and technology involved in the production of various food products, with a focus on cereal grains, legumes, oilseeds, bakery and snack items, as well as meat, fish and egg products

Theory

Cereal grains, legumes and oilseeds: Structure and composition of cereals, legumes and oilseeds, milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour.

Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in manufacture of value added food products including malted milk foods.

Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates/ isolates, Utilization of oil cake in food formulation.

Bakery and Snack technology: Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti, Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips.

Meat, fish and egg technology: Development of meat, poultry, egg and fish industry in India, Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish;, Manufacturing process of dehydrated fish and fish pickles; Cleaning and sanitation, Waste management of food processing plants.

Practical

Manufacture of barley malt; Determination of cooking quality of rice; Manufacture of bread and bun; Manufacture of biscuits; Preparation of noodles; Preparation of cake; Manufacture of potato chips; Preparation of malt based food products; Manufacture of malted milk foods, Manufacture of soy beverage and tofu, Preparation of salami; Preparation of chicken soup; Manufacture of chicken pickle.

Suggested reading

1. Bamforth, C. W. and Barclay, A. H. (1993) Malting technology and the uses of malt. In: Barley: Chemistry and Technology, Alexander W. MacGregor and Rattan S. Bhatty (Eds.) pp. 297-354, American Association of Cereal Chemists, St. Paul, MN, USA.
2. Biscuit and Cracker Manufacturers Association (1981) Biscuit and Cracker Handbook, Washington, DC.
3. Chavan, J. K. and Kadam, S. S. (1989) Nutritional improvement of cereals by fermentation. CRC Crit. Rev. Food Sci. Technol., 28: 349-400.

4. Dhillon, L.S. (2005) Manufacturing of malt- milk based food products. Indian Dairyman, 57: 59-66.
5. Fast, R.B. and Caldwell, E.F. (1993) Breakfast Cereals and How They Are Made, American Association of Cereal Chemists, Inc., St. Paul, Minnesota, USA.
6. Hoseney, R.C., Wade, P. and Finely J.W. (1988) Soft Wheat Products, In: Wheat Chemistry and Technology, 3rd edn. (Y. Pomeranz, ed.) American Association of Cereal Chemists, St. Paul, MN.
7. Kulp, K. and Ponte, J.G. Jr. (2000) Handbook of Cereal Science and Technology, 2nd Edition, Marcel Dekker, Inc., New York, USA.
8. Lorenz, K.J. and Kulp, K. (1991) Handbook of Cereal Science and Technology, Marcel Dekker, Inc., New York, USA.
9. Matz, S. A. (1969) Cereal Science, Samuel A. Matz (Ed.) pp. 79-96. The AVI Publishing Company Inc., England.
10. NIN (2004) Nutritive Value of Indian Foods by: Gopalan, C., Rama Sastri, B. V. and Balasubramanian, Revised & Updated by: Narasinga Rao, B. S., Deosthale, Y. G. and Pant, K. C., National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.
11. Pomeranz, Y. and D. B. Bechtel (1978) Structure of cereal grains as related to end-use properties. Postharvest Biology and Biotechnology. H. O. Hultin and M. Milner, eds., Food and Nutrition Press, Inc., Westport, CN.

Sensory Evaluation of Dairy Products 2 (1+1)

Objective

To provide students with a comprehensive understanding of sensory evaluation techniques as applied to dairy products

Theory

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Terminology related to sensory evaluation; Design and requirements of a sensory evaluation laboratory; Basic principles: senses and sensory perception; Physiology of sensory organs; Classification of tastes and odours, threshold value; Factors affecting senses, visual, auditory, tactile and other responses.

Fundamental rules for scoring and grading of milk and milk products; Procedure and types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, hedonic scale and descriptive tests; Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements.

Milk: score card and its use; Judging and grading of milk, defects associated with milk; Cream: desirable attributes and defects in cream, Score card for cream, sensory evaluation of different types of cream; Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter; Ghee: grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee.

Fermented milks: desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks; Frozen dairy

products: desirable and undesirable characteristics of frozen dairy products; Sensory evaluation of ice cream, kulfi and milk sherbets; Cheese: sensory attributes of some common cheese varieties and their defects, score card for cheese; Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses; Dried dairy products: desirable and undesirable characteristic of dried milks; Sensory evaluation and grading of dry milk products; Concentrated milks: desirable attributes and defects; Sensory evaluation and grading of evaporated and condensed milk; Heat desiccated Indian milk products: desirable and undesirable characteristics.

Sensory evaluation of khoa and khoa based sweets; Acid coagulated Indian milk products: desirable arid undesirable characteristics; Sensory evaluation of paneer, chhana and chhana based sweets; Consumer acceptance studies: Objectives, methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and consumers studies, limitations; Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests.

Practical

Determination of threshold value for basic tastes; Determination of threshold value for various odours; Selection of sensory evaluation panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Sensory evaluation of milk and cream; Sensory evaluation of butter and ghee; Sensory evaluation of condensed and evaporated milk; Sensory evaluation of milk powders; Sensory evaluation of cheese and related products; Sensory evaluation of frozen products; Sensory evaluation of khoa and khoa-based sweets; Sensory evaluation of chhana and chhana based sweets; Sensory evaluation of dahi and fermented dairy products; Preparation of milk and milk products with defects, techniques for simulation; Novel techniques of sensory evaluation.

Suggested reading

1. Amerine, M.A., Pangborn, R.M. and Roessler, E.B. (1965). Principals of Sensory Evaluation of Food. Academic Press, New York.
2. Eggert, J. and Zook, K. (Eds). (1986). Physical Requirement Guidelines for Sensory Evaluation Laboratories. ASTM STP 913. American Society Testing and Materials, Philadelphia, PA.
3. Kemp, S.E., Hollowood, T. and Hort, J. (2009). Sensory Evaluation: A Practical Handbook. Wiley Blackwell, John Wiley and Sons Ltd. Publ., USA.
4. Meilgrard, M.J., Civille, C.V. and Carr, B.T. (2007). Sensory Evaluation Techniques. 4th ed. CRD, Boca Raton, F.L.
5. Russell, G. M. (1984). Some Basic Consideration in Computerizing the Sensory Laboratory. Food Tech, 38(9), 67-70.

Biochemistry and Human Nutrition 2 (1+1)

Objective

To develop understanding of fundamental principles of biochemistry and human nutrition including macro and micro nutrients requirements and the associated molecular and metabolic mechanism

Theory

Bio-Molecules: General structures, classification and functions of Biomolecules-Amino acids, Protein Structure, Carbohydrates, Fats, Lipids, DNA and RNA.

Enzymes: Activation energy /Transition state and Enzyme Classification, Coenzymes/Co-factors and Enzyme kinetics, Mechanism of enzyme action, Factors effecting enzyme activity, Enzyme inhibition, isozymes and Regulatory Enzymes, Immobilization of enzyme, Ribozymes and Zymogens.

Metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Glycogen synthesis and degradation, Pentose phosphate pathway, Fatty acid oxidation, Urea cycle and transaminase reactions, ATP and Electron transport chain.

Fundamentals of human nutrition, concept of balanced diet, nutrient requirements of different age groups; Methods of evaluation of nutritive value of food and nutritional value of cow, buffalo and human milk, biochemical composition and energy value of foods with special reference to milk and dairy products.

Nutrition, digestion and absorption, Vitamins (structure and function), Hormones (structure and function), Milk intolerance and hypersensitivity, Concept of functional foods and Nutraceutical, Milk based functional foods.

Practical

Estimation of alkaline phosphatase by conversion of a non-chromogenic substrate to a chromogenic substrate; Effect of temperature, pH and enzyme inhibitors on the activity of the enzyme; Estimation of catalase by spectrophotometric method; Determination of the Michaelis Menten constant of an enzyme; Estimation of RNA by colorimetric method; Estimation of DNA by colorimetric method; Estimation of Ascorbic acid in plasma; Estimation of serum Protein (Biuret method /Lowry method); Estimation of Blood Glucose (Folin Wu method); Estimation of Serum inorganic phosphorus (Fiske and Subba Row method);Estimation of blood creatinine, triglyceride and cholesterol levels; Estimation of calorific value of food items; Diet and nutrition surveys: (a) Identification of vulnerable and risk groups; (b) Diet survey for breast-feeding and weaning practices of specific groups; (c) Use of anthropometric measurement in children; Preparation of visual aids for nutritional disorders; Field visit to (a) Observe the working of nutrition and health oriented program (survey based result); (b) Hospitals to observe nutritional deficiencies; Identification of Mono, Di and Polysaccharides; Identification of Proteins (albumin, gelatin, peptone).

Suggested reading

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2002). Biochemistry. 5th edn. W. H. Freeman, New York.
2. Conn, E.E. and Stumpf, P.K. (2010). Outlines of Biochemistry. 5th edn. John Wiley and Sons, New York.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry. 4th edn. Garland Science, New York.
4. Nelson, D.L. and Cox, M.M. (2005). Lehninger's Principles of Biochemistry. 5th edn. W. H. Freeman, New York.

5. Staynarayana, U. and Chakrapani, U. (2006). Text Book of Biochemistry. 3rd edn. Oxford and IBH Publishers, New York.

6. Voet, D., Voet, J. G. and Pratt, C. W. (2006). Fundamentals of Biochemistry: Life at the Molecular Level, 3rd edn. John Wiley and Sons, USA.

ELECTIVE COURSES

(Total 8 credits of electives are to be taken out of the following indicative courses)

Course Title	Credit
Industrial Statistics	2 (1+1)
Fundamentals of Dairy Extension	2 (1+1)
Dairy Biotechnology	2 (1+1)
Instrumental Technique in Food Analysis	2 (1+1)
Food Additives and Preservatives	2 (1+1)
Design and Formulation of Foods	3 (2+1)

Industrial Statistics 2 (1+1)

Objective

To equip students with the knowledge and skills required to collect, analyze, and interpret data relevant to dairy and animal husbandry sector

Theory

Definition and scope; sources of animal husbandry and dairy statistics; Measures of central tendency, Measures of dispersion, Moments, skewness and kurtosis; Elementary notions of probability, Laws of addition and multiplication probability.

Theoretical frequency distributions: Binomial, Poisson and Normal distribution and their application; Concepts of sampling methods, Introduction to testing of hypotheses, Tests of Significance-Z, t, F tests, and their application in the field of dairying.

Analysis of variance- One-Way and two-way classification; Simple correlation coefficient and its test of significance, Linear regression, rank correlation.

Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

Practical

Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis Fitting of binomial and Poisson distribution; Application of 'Z' test for one and two sample problems; Application of 't' test for one and two sample problems; Application of Chi-square test and F-test; Correlation and regression; Rank correlation coefficient; Control chart for variables and attributes.

Suggested reading

1. Agarwal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd., New Delhi.

2. Amble, V. N. 1975. Statistical Methods in Animal Sciences. Indian Society of Agril. Statistics, New Delhi.
3. Goon, A. M., Gupta, M.K. and Gupta, B. D. 1979. Fundamental of Statistics. Vol. I and II. The World Press Pvt. Ltd., Kolkata.
4. Goulden, C.H. 1959. Methods of Statistical analysis. John Wiley and Sons, New York.
5. Gupta, S.C. 1987. Fundamental of Statistics. Himalaya Publishing House, New Delhi.
6. Gupta, S.C. and Kapoor, V.K. 1990. Fundamentals of Applied Statistics. Sultan Chand & Sons, New Delhi.
7. Gupta, S.P. 2010. Statistical Methods. Sultan Chand and Sons, New Delhi.
8. Handbook on Statistical Quality Control. 1986 . Indian Standards Institute, New Delhi.
9. Moroney, M.J. 1975. Facts from Figures. Penguin Books, England.
10. Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH Publishing Co., New Delhi.

Fundamentals of Dairy Extension 2 (1+1)

Objective

To provide students with a basic understanding of extension education principles and practices within the context of dairy and animal husbandry

Theory

History, need, definition, philosophy, principles, approaches and objectives of extension education; Present status of dairy and animal husbandry development programme launched in pre and post-independence era; Teaching and learning process, Extension Teaching Methods, classification and selection of teaching methods; Importance of Audio-Visual-Aids; Identification of rural leaders, their characteristics, role and function in rural development, training of rural leaders; Principle of working with group and their mobilisation; Need, principle and step of programme planning; Evaluation of extension program; Diffusion of innovations and categories of farmers; Problems of different stake holders, Conceptual orientation about different terms, like- RRA, PRA, IVLP/TAR, ATMA, ATIC, PTD, etc.

Practical

Acquiring skill in use of audio-visual and other aids: Hands-on training on use of LCD projector, PA system, camera; Skills in preparation of documents including script writing; Preparation and use of audio-visual aids including animation for dairy stakeholders Group discussion technique, Hands on learning of field problems in dairy and animal husbandry.

Suggested reading

1. Adams, M.E. (1982). Agricultural Extension in Developing Countries. Longman, Singapore Publ.
2. Blackburn, D.J. and Vist, D.L. (1984). Historical Roots and Philosophy of Extension. In D. J. Blackburn (Ed.), Extension handbook, University of Guelph, Guelph, Ont., Canada.
3. Burton, E.S., Robert, P.B. and Andrew, J.S. (1997). Improving Agricultural Extension – A Reference Manual. FAO, Rome.

4. Chouhan, J. (2006). Communication and Extension Management. Anjali Prakashan, Kanpur.
5. Dahama, O.P. and Bhatnagar, O.P. (1987). Education and Communication for Development. Oxford & IBH.
6. Farrington, J., Pal, S., Sulaiman, R. V. (1998). Improving the Effectiveness of Agricultural Research and Extension in India, Policy Paper 8, NCAP, New Delhi.
7. Hayward, J. 1990. Agricultural Extension: The World Bank's Experience and Approaches. In FAO Report of the Global Consultation on Agricultural Extension (p. 115-134). Rome: FAO.
8. Jha, D. and Kandaswamy, A. (Eds). (1994). Decentralising Agricultural Research and Technology Transfer in India. ICAR, New Delhi.
9. Kumar, B. and Hansra, B.S. (2000). Extension Education for Human Resource Development. Concept Publishing Company, New Delhi.
10. Macklin, M. (1992). Agricultural Extension in India. Technical Paper 190, World Bank, Washington, DC.
11. Mook, B. T. (1982). The world of the Indian Field Administrator. Vikas Publishing House. New Delhi.
12. Moris, J. (1991). Extension Alternatives in Tropical Africa. Overseas Development Institute, London.
13. Owen, E., Kitalyi, A., Jayasuriyia, N. and Smith, T. (Ed). (2005). Livestock and Wealth Creation – Improving of the Husbandry of Animals kept by Resource Poor People in Developing Countries. Nottingham Univ. Press, UK.
14. Ray, G.L. (1991). Extension Communication and Management. Naya Prokash, Calcutta
15. Reddy, A.A. (1993). Extension Education. Shree Laxmi Press, Bapatla, Andhra Pradesh.
16. Rivera, W.M. and Gustafson, D.J. (Ed). 1991. Agricultural Extension: Worldwide: Institutional Evolution and Forces for Change, Elsevier.
17. Samanta, R.K. (1993). Extension Strategy for Agricultural Development in 21st Century. Mittal Publications, New Delhi.
18. Swanson, B.E. (Ed). (1984). Agricultural Extension: A Reference Manual. 2nd edn. FAO, Rome.
19. Van den Ban, A.W. and Hawkins, H.S. (1998). Agricultural Extension. Longman Scientific Tech., UK.

Dairy Biotechnology 2 (1+1)

Objective

To provide students with understanding of biotechnological applications in dairy industry.

Theory

Definition, scope and historical development of biotechnology, achievement and future application. Structure of DNA and RNA; DNA replication, protein synthesis, genetic code, mutations. Vectors, cloning strategies in bacteria and animals, rDNA technology and Protoplast fusion; Application of biotechnology in food and dairy industry, dairy effluents; Genetic manipulation of dairy starters for improved attributes of commercial value; Dairy enzymes and whole cell immobilization; Ethical issues related to use of genetically modified foods; Ethical issues related to use of genetically modified foods.

Practical

Isolation of plasmid and genomic DNA from bacteria (E; coli, lactic acid bacteria); Agarose gel electrophoresis of DNA fragments); Restriction analysis of DNA; Curing of plasmids; Preparation of competent cell; Transformation of *E; coli* by calcium chloride treatment/ electro oration; Conjugal transfer in *E; coli* cells; Preparation of protoplasts and protoplast fusion; PCR technique demonstration; Visit to a biotechnology lab.

Suggested reading

1. Belitz, H.D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
2. Deshpande, S.S. (2002). Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Mahindru, S.N. (2008). Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

Instrumental Techniques in Food Analysis 2 (1+1)

Objective

To expose students to principles and theory of selected instrumental methods used in food analysis

Theory

Concepts of food analysis; Rules and regulations of food analysis.

Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods. Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry. Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Quality evaluation of raw materials: Fruits products; Quality evaluation of raw materials: vegetables products; Quality evaluation of raw materials: cereals products; Quality evaluation of raw materials: dairy products; Quality evaluation of food products for color and taste of marketed products (sweet); Quality evaluation of food products for color and taste of marketed products (carbonated drinks; Quality evaluation of food products for color and taste of marketed products (Processed food); Quality evaluation of food products for color and taste of marketed products (Chili powder); Estimation

of phytic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Analysis of heavy metals using atomic absorption spectrophotometer (mercury/ lead/arsenic/tin); Identification of organic acids by paper electrophoresis; Estimation of vitamins (A) using HPLC; Estimation of vitamins (thiamine) using HPLC; Estimation of vitamins (riboflavin) using HPLC; Estimation of vitamins (nicotinamide) using HPLC; Estimation of lycopene using HPLC; Estimation of betacarotein using HPLC; Estimation of vitamins A using HPLC; Analysis of foods for drug residues in milk/milk products; Analysis of foods for pesticide residues in fruit; Analysis of foods for pesticide residues in vegetable; Analysis of foods for pesticide residues in spices; Spectrophotometric method of total chlorophyll (A and B); Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE; Fatty acid profiling using gas chromatograph.

Suggested reading

1. Nielsen, S. Suzanne. (2003). Food Analysis. 3rd edn. Kluwer Academic, New York, USA.
2. Nielsen, S. Suzanne. (2010). Food Analysis Laboratory Manual. 2nd edn. Springer, NY, USA.
3. Semih Ötles. (2009). Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
4. Sun, Da-Wen. (2008). Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

Food Additives and Preservatives 2 (1+1)

Objectives

1. To introduce the different additives and preservatives used in food industry.
2. To understand the mode of action of additives and preservatives used in food products. Students will also be familiarized with regulatory requirements of food additives.

Theory

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action; Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic);Identification of food colour by TLC (organic and inorganic);Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in foods; Role of leavening agent in baked food product; Preservation of food samples using humectants.

Suggested reading

1. Belitz, H. D., Grosch, W. and Schieberle, P. (2009). Food Chemistry. 4th edn. Springer-Verlag, Berlin, Heidelberg.
2. Deshpande, S.S. (2002). Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.
3. Mahindru, S. N. (2008). Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

Design and Formulation of Foods 3 (2+1)

Objectives

1. Understand about RDA for Indians
2. Design and formulation of new and innovative target foods
3. Gain knowledge about various functional foods

Theory

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people; Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition; Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation; Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods; Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Suggested Reading

1. Antia, F.P. 1974. Clinical Dietetics and Nutrition, Oxford Medicine Publications.
2. Davidson, S., Passmore, R. and Eastwood, M.A. 1986. Davidson and Passmore Human Nutrition and Dietetics. Churchill Livingstone.

3. Gopalan, C., Ramshastri, B.V., Balasubramaniam, S.C. 1989. Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad.
4. Pokorny, J., Yanishlieva, N. and Gordon, M. 2001. Antioxidants in Food, Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science, 5th edn. Chapman & Hall, NY, USA.
6. Mazza, G.1998. Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson, C. 1975. Basic Nutrition and Diet Therapy, Macmillan.
8. Swaminathan, M.1974. Essentials of Nutrition, Ganesh Co.
9. Steinkrauss, K.H. 1995. Handbook of Indigenous Fermented Foods, Marcel Dekker.

SEMESTER-VIII

S; No;	Course Title	Credit Hours
1	In-plant Training	One Semester (0+20)
	Total	20 (0+20)
For B. Tech; program: Course at 1 to be offered (20 credits) In-plant training for one semester to be carried out at a Dairy processing plant		

- In eighth semester of the degree program students will be offered Internship (In-plant training) of 20 credits.
- The Training will be carried out at a commercial dairy plant.
- The students will be exposed to processing, production, testing and quality assurance and marketing of dairy products at commercial scale.
- The students would be required to submit a certificate of completion of the training from the concerned authorities of the company.

ONLINE COURSES

The students will have to take a minimum of 08 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Dairy Technology). The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by the Institute/ University offering the courses. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student. The courses can be taken during whole span of degree parogramme as per choice of students. The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course). The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

List of Suggestive Online Course

Course Title	Duration	Credit
Digital Media	16 weeks	1
Basics of Photography	12 weeks	1
Design, Technology and Innovation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	1
Consumer Protection Legislation	8 weeks	1
Communication and Extension for Sustainable Development	15 weeks	1
Intellectual Property	12 weeks	1
Biopsychology	15 weeks	1
NGO'S and Sustainable Development	15 weeks	1
Counselling Psychology	12 weeks	1
Gender Sensitization: Society Culture and Change	16 weeks	1
Basics of Health Promotion and Education Intervention	8 weeks	1
Psychology of Stress, Health and Well-being	12 weeks	1
Diet Management in Health & Disease	12 weeks	1
Dairy and Food Process and Products Technology	12 weeks	1
Thermal Processing of Foods	12 weeks	1
Nano-technology, Science and Applications	8 weeks	1
Food Science & Processing	12 weeks	1
Diet Management in Health & Disease	8 weeks	1
Human Nutrition and Biochemistry	12 weeks	1
Personality Development and Communication Skills	8 weeks	1
Public Speaking	8 weeks	1
Personality Development	8 weeks	1
Personality Development	8 weeks	1
Yoga Practices 1	12 weeks	1
Yoga Practices 2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1
Information Sources and Library Services	6 weeks	1
Qualitative Research Methods and Research Writing	12 weeks	1
Food Science & Processing	12 weeks	1
Food Safety & Quality Control	8 weeks	1
Communication Skills and Computer Operations	24 weeks	1
Human Resource Management	24 weeks	1
Business Plan and Finance Management	24 weeks	1

SAUs will be free to include more Elective courses with approval from their competent bodies.

* The list of online courses will be uploaded on College/University website. The student will have choice to select courses of his/her choice up to 08 credits.

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