CURRICULA AND SYLLABI

B.TECH. (FOOD TECHNOLOGY)
2024

KERALA AGRICULTURAL UNIVERSITY

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING & FOOD TECHNOLOGY

TAVANUR, KERALA-679573

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Course Curricula for Undergraduate Programs in Food Technology: UG-Certificate (Food Technology), UG-Diploma (Food Technology), and B.Tech. (Food Technology)

Introduction

In an era marked by rapid population growth, changing dietary patterns, and environmental concerns, the significance of food technology cannot be overstated. Food Technology course is designed to address the multifaceted challenges facing the food industry today. It recognizes the need for a holistic approach to food technology education that encompasses theoretical knowledge, practical skills, and ethical considerations. At its core, the course aims to produce graduates who are well-equipped to address issues such as food security, safety, new product development, sustainability, and innovation.

In view of this, the under-graduate programs in Food Technology have been designed to focus on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has been made for advanced skill development through project work or experiential learning/ incubation, etc. Such activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and analytical thinking.

One of the fundamental pillars of the program on Food Technology course is the emphasis on practical application. Recognizing the importance of hands-on learning experiences, laboratory work, and industry internships, the course has been designed to provide students with real-world exposure to the complexities of food processing, preservation, and quality assurance. By integrating practical training into the curriculum, students can develop essential skills that are crucial for success in the food industry. Two exit options, one after first year as a Certificate and the other after the second year as Diploma in Food Technology, have been provided, so that the students can look for employment at any point of their career.

The course on Food Technology advocates for an interdisciplinary approach to education. It recognizes that food technology is inherently multidisciplinary, drawing upon principles from fields such as biology, chemistry, microbiology, engineering, and nutrition. By incorporating elements from these diverse disciplines, students gain a comprehensive understanding of food science and are better equipped to tackle complex challenges in the field. Moreover, the course has far-reaching implications for the future of food. By equipping students with comprehensive knowledge, practical skills, and ethical principles, the syllabus lays the foundation for a sustainable, resilient, and equitable food system. Graduates of the program are poised to make meaningful contributions to the food industry, driving innovation, promoting food security, and ensuring the safety and integrity of the global food supply.

Entrepreneurship in food technology is an aspect that is characterized by a spirit of innovation and disruption. Entrepreneurs in this field leverage cutting-edge technologies, scientific advancements, and creative thinking to develop novel solutions that revolutionize the way we produce, process, and consume food. These entrepreneurs are driving forward-thinking initiatives that have the potential to reshape the future of food.

The Food Technology course represents a landmark initiative aimed at transforming education in this critical field. By emphasizing practical application, interdisciplinary learning, innovation, and food safety, the program seeks to empower students with the knowledge and skills needed to address the complex challenges facing the food industry. As we look towards the future, the course curricula on Food Technology holds immense promise for shaping a more sustainable, resilient, and equitable food system for generations to come.

Highlights

- The B. Tech. (Food technology) Program will be of 4 years, covering 181 credits, which has 175 credits (inclusive of four credits of two non-gradial courses i.e. (Deeksharambh (Induction- cum-Foundation course): 2 credits and Study tour: 2 credits), offered by the parent institute. Additionally, 6 credits of online courses are to be taken by the student as per his/ her choice.
- More weightage has been given to skill development courses in first two years, semesters 1 to 4. Students have been given flexibility and choice in selection of skill development courses from a basket of multiple skill development modules offered in all the four semesters of first two years.
- The UG Certificate is being offered in three domains viz., Food Plant Operations, Food Manufacturing and Food Quality Testing for which a bouquet of courses has been offered to enhance their skill in the particular domain.
- Students will be given 4 credits of skill-based courses each in first, second, and 2 each in third and fourth semesters so that they will acquire enough knowledge and skill through hands-on training in related domain.
- The students will have flexibility and choice in selection of skill areas from a bouquet of skill enhancement modules to be offered/ listed by the parent institute. After three days common orientation on different skill enhancement modules, students will take up either one or more modules as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.
- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running the Skill Enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.
- In first year, after completing the course requirement of 45 credits of both the semesters, there is provision of extra 10 credits Internship of two months period for Industry placement/ Industry exposure/ Hands-on with local food processors/equipment manufacturers, etc. in related domain of skill acquired to get first-hand experience to become eligible for the award of UG-Certificate on exit.
- The second year has been designed with the basic engineering courses as well as fundamental courses in food technology with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of Food Technology. After satisfactory completion of the courses of 2nd year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-

Diploma in Food Technology on exit. The students continuing the study further, would not have to attend the internship after 2nd year.

- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given in proper amalgamation of theory and practical to provide them hard core knowledge of the B. Tech. (Food Technology) discipline as well. In third year, the student will be taught Intensive core courses of Food Technology.
- Six credits of online courses are at the discretion of students. Students have the choice of taking online courses to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these Non-credit elective courses of 6 credits any time during the 3rd and 4th years. These courses are to be completed with satisfactory grade.
- In eighth semester of the degree program students will be offered Internship of 20 credits.
- On successfully completing the four years degree requirement, the student will be given undergraduate degree of B. Tech. (Food Technology).

Entry and exit Options

The entry and exit options for the UG programs in Food Technology are shown in the figure 1 below.

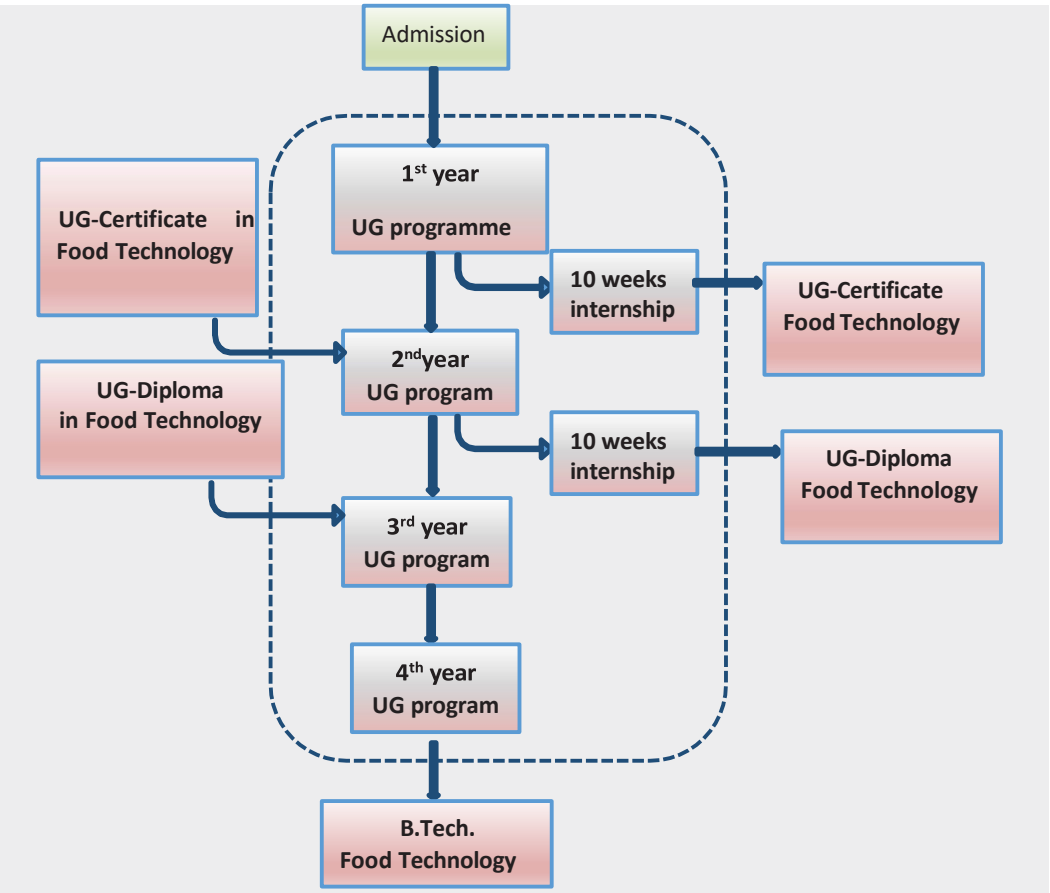

Fig.1. Entry and exit options for the UG programs in Food Technology

Eligibility for Entry into 1st year UG program: +2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU.

Exit options

1. **UG-Certificate in Food Technology** (exit after first year and completion of 10 weeks' internship) with following specialization; e.g. UG certificate in Food technology (Food Plant Operations).
   a. Food Plant Operations
   b. Food Manufacturing
   c. Food Quality Testing
2. **UG-Diploma in Food Technology** (exit after second year and completion of 10 weeks' internship).
3. **B.Tech. (Food Technology)** (on successful completion of four-year degree requirements).

Academic Program

Semester-wise distribution of courses

First Year		
Semester I		
S. No.	**Course Title**	**Credit Hours**
1.	CFT 1101 *Deeksharambh* (Induction-cum-Foundation Course (2 weeks)	2 (0+2) Non-Gradial (NG)
2.	FPT 1101 Fundamentals of Food Processing	3 (2+1)
3.	FMP 1114 Workshop Technology	3 (1+2)
4.	FMP 1115 Basic Electrical Engineering	3 (2+1)
5.	FSQ 1101 General Microbiology	3 (2+1)
6.	BES 1115 Farming Based Livelihood System	3 (2+1)
7.	BES 1116 Communication Skills	2 (1+1)
8.	CFT 1102 NSS-I / CFT 1103 NCC-I	1 (0+1)
9.	Skill Enhancement Course - I*	2 (0+2)
10.	Skill Enhancement Course - II*	2 (0+2)
Total		**22 (10+12) + 2 (NG)**

Semester II		
S. No.	**Course Title**	**Credit Hours**
1.	FPE 1201 Post-Harvest Engineering	3 (2+1)
2.	FSQ 1202 Food Chemistry I	3 (2+1)
3.	FPE 1202 Unit Operations in Food Processing	3 (2+1)
4.	FPE 1203 Food Thermodynamics	3 (2+1)
5.	FPE 1204 Engineering Drawing and Graphics	3 (1+2)
6.	SWC 1208 Environmental Studies and Disaster Management	3 (2+1)
7.	CFT 1204 NSS-II / CFT 1205 NCC-II	1 (0+1)
8.	Skill Enhancement Course - III*	2 (0+2)
9.	Skill Enhancement Course - IV*	2 (0+2
Total		**23 (11+12)**

Proposed Basket of Skill Enhancement Courses for Semester I to VI.

Department/ Discipline	**S. No.**	**Course Title**	**Credit hours**
Food Process Technology	1	SFT --01 Introduction to Drying Technology and Dryers	2 (0+2)
	2	SFT --02 Introduction to Processing of Extruded Foods	2 (0+2)
	3	SFT --03 Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)
	1	SFS --01 Introduction to Food Safety and Sanitation	2 (0+2)

Food Safety and Quality Assurance	2	SFS --02 Introduction to Good Laboratory Practices	2 (0+2)
	3	SFS --03 Basic Food Analysis Laboratory Techniques	2 (0+2)
Food Process Engineering	1	SFE --01 Introduction to Electrical and Control Systems in the Food Industry	2 (0+2)
	2	SFE --02 Introduction to Mechanical Systems in Food Industry	2 (0+2)
	3	SFE --03 Introduction to AutoCAD	2 (0+2)
Food Plant Operations	1	SFP --01 Maintenance of Food Processing Equipment	2 (0+2)
	2	SFP --02 Introduction to Bottling and Canning Line	2 (0+2)
	3	SFP --03 Introduction to Manufacturing of Bakery Products	2 (0+2)

From Basket of Skill enhancement course modules, only one course from each discipline is to be selected per semester as per the selected specialization of certificate. However, at least one course of other specialization viz. Food Process Technology, Food Process Engineering and Food Safety and Quality Assurance is to be taken for the Diploma course.

Student taking various SKILL Enhancement Courses will be eligible to get a Certificate with Nomenclature as follows, provided the student has selected courses as mentioned against the nomenclature of the UG-Certificate.

Nomenclature of Certificate	**Skill Enhancement Courses to be selected from the respective disciplines**	
	Semester I	**Semester II**
UG-Certificate in Food Technology (Food Plant Operations)	Food Process Engineering	Food Plant Operations
UG-Certificate in Food Technology (Food Manufacturing)	Food Process Technology	Food Plant Operations
UG-Certificate in Food Technology (Food Quality Testing)	Food Safety and Quality Assurance	Food Plant operations

In case a student wishes to exit at this point,

Post-SEMESTER II

Course Title	**Credit hours**
IFP 1201 Internship-I (only for exit option for award of UG-Certificate) - 10 weeks	10 (0+10)

There is no need to do the internship if the student wishes to continue further study.

Second Year		
Semester III		
S. No.	**Course Title**	**Credit Hours**
1.	FSQ 2103 Food Chemistry II	3 (2+1)
2.	FPE 2105 Fluid Mechanics	3 (2+1)
3.	FPE 2106 Heat and Mass Transfer in Food Processing	3 (2+1)
4.	BES 2117 Basic Electronic Engineering	2 (1+1)
5.	FSQ 2104 Food Microbiology	3 (2+1)

6.	BES 2118 Engineering Mathematics- I	2 (2+0)
7.	BES 2119 Agricultural Informatics and Artificial Intelligence	3 (2+1)
8.	Skill Enhancement Course - V*	2 (0+2)
Total		**21 (13+8)**

Semester IV		
S. No.	**Course Title**	**Credit Hours**
1.	FPE 2207 Fundamentals of Food Engineering	3 (2+1)
2.	FSQ 2205 Food Plant Sanitation	3 (2+1)
3.	FSQ 2206 Food Quality, Safety Standards and Certification	2 (2+0)
4.	BES 2221 Engineering Mathematics- II	2 (2+0)
5.	FPO 2201 Food Plant Utilities and Services	3 (2+1)
6.	BES 2222 Entrepreneurship Development and Business Management	3 (2+1)
7.	BES 2223 Personality Development	2 (1+1)
8.	BES 2220 Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)
9	Skill Enhancement Course - VI*	2 (0+2)
Total		**22 (13+9)**

Student taking various Skill Enhancement Courses* can exit here to get a UG-Diploma in Food Technology.

Post-SEMESTER IV

Course Title	**Credit hours**
IFP 2202 Internship-II (only for exit option for award of UG- Diploma) 10 weeks	10 (0+10)

There is no need to do the internship if the student wishes to continue further study.

Third Year		
Semester V		
1.	FSQ 3107 Food Biochemistry and Nutrition	3 (2+1)
2.	FPT 3102 Processing Technology of Cereals	3 (2+1)
3.	FPT 3103 Processing Technology of Fruits and Vegetables	3 (2+1)
4.	FPT 3104 Food Packaging Technology and Equipment	2 (1+1)
5.	FPT 3105 Processing of Spices and Plantation Crops	3 (2+1)
6.	FPE 3108 Food Storage Engineering	3 (2+1)
7.	BES 3124 Project Preparation and Management	2 (1+1)
8.	BES 3125 Agricultural Marketing and Trade	3 (2+1)
9.	FTR 3101 Study tour (10-12 days during the semester)	2 (0+2) NG
Total		**22 (14+8) + 2 (NG)**

Semester VI		
S. No.	**Course Title**	**Credit Hours**
1.	FSQ 3208 Food Additives and Preservatives	2 (1+1)
2.	FPT 3206 Sensory Evaluation of Food Products	2 (1+1)
3.	FPT 3207 Processing Technology of Legumes and Oilseeds	3 (2+1)
4.	FPE 3209 Food Refrigeration and Cold Chain	3 (2+1)
5.	FPT 3208 Processing of Meat, Fish and Poultry Products	3 (2+1)
6.	FPT 3209 Processing Technology of Beverages	3 (2+1)
7.	FPT 3210 Bakery, Confectionery and Snack Products	3 (2+1)
8.	FPT 3211 Processing Technology of Liquid Milk	2 (1+1)
Total		**21 (13+8)**

Fourth Year		
Semester VII		
1.	FPE 4110 Food Process Equipment Design	3 (2+1)
2.	FPT 4112 Processing Technology of Dairy Products	3 (2+1)
3.	BES 4126 ICT Applications in Food Industry	3 (1+2)
4.	FSE 4101 Seminar	1 (0+1)
5.	Elective Courses	10
Total		**20**

Student has to complete 20 credits in this semester. Courses 1-4 (10 credits) are compulsory. (Minimum 10 credit hours from this Suggestive list of courses should be opted as Elective Courses).

Elective Courses

S. No.	**Course Title**	**Credit Hours**
1.	EFT 4101 Design and Formulation of Foods	3 (2+1)
2.	EFS 4101 Industrial Microbiology	3 (2+1)
3.	EFS 4102 Introduction to Food Biotechnology	3 (2+1)
4.	EBE 4108 Business Management and Economics	2 (2+0)
5.	EBE 4109 Statistical Methods and Numerical Analysis	2 (1+1)
6.	EBE 4110 Instrumentation and Process Control in Food Industry	3 (1+2)
7.	EFS 4103 Instrumental Techniques in Food Analysis	3 (2+1)
8.	EFT 4102 Traditional Indian Dairy Products	2 (1+1)
9.	EFT 4103 Ice-Cream and Frozen Desserts	3 (2+1)
10.	ERE 4104 Energy Conservation and Management	2 (1+1)
11.	ERE 4105 Applications of Renewable Energy in Food Processing	2 (1+1)

12.	EFE 4101 Food Plant Design and Layout	3 (2+1)
13.	EFE 4102 Waste and By-Products Utilization	3 (2+1)

Semester VIII		
S. No.	**Course Title**	**Credit Hours**
1.	IFP 4203 Student-Ready Internship (at Industry/ Research Institutes etc.) 20 weeks	20 (0+20)

*From the available basket of skill enhancement modules

Department wise distribution of courses

Department of Food Process Technology

S. No.	Course Title	Credit
1.	FPT 1101 Fundamentals of Food Processing	3 (2+1)
2.	FPT 3102 Processing Technology of Cereals	3 (2+1)
3.	FPT 3103 Processing Technology of Fruits and Vegetables	3 (2+1)
4.	FPT 3104 Food Packaging Technology and Equipment	2 (1+1)
5.	FPT 3105 Processing of Spices and Plantation Crops	3 (2+1)
6.	FPT 3206 Sensory Evaluation of Food Products	2 (1+1)
7.	FPT 3207 Processing Technology of Legumes and Oilseeds	3 (2+1)
8.	FPT 3208 Processing of Meat, Fish and Poultry Products	3 (2+1)
9.	FPT 3209 Processing Technology of Beverages	3 (2+1)
10.	FPT 3210 Bakery, Confectionery and Snack Products	3 (2+1)
11.	FPT 3211 Processing Technology of Liquid Milk	2 (1+1)
12.	FPT 4112 Processing Technology of Dairy Products	3 (2+1)
Elective Courses		
1.	EFT 4101 Design and Formulation of Foods	3 (2+1)
2.	EFT 4102 Traditional Indian Dairy Products	2 (1+1)
3.	EFT 4103 Ice-Cream and Frozen Desserts	3 (2+1)
Skill Enhancement Courses		
1.	SFT --01 Introduction to Drying Technology and Dryers	2 (0+2)
2.	SFT --02 Introduction to Processing of Extruded Foods	2 (0+2)
3.	SFT --03 Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)

Department of Food Process Engineering

1.	FMP 1114 Workshop Technology	3 (1+2)
2.	FMP 1115 Basic Electrical Engineering	3 (2+1)
3.	FPE 1201 Post-Harvest Engineering	3 (2+1)
4.	FPE 1202 Unit Operations in Food Processing	3 (2+1)
5.	FPE 1203 Food Thermodynamics	3 (2+1)
6.	FPE 1204 Engineering Drawing and Graphics	3 (1+2)
7.	FPE 2105 Fluid Mechanics	3 (2+1)
8.	FPE 2106 Heat and Mass Transfer in Food Processing	3 (2+1)
9.	FPE 2207 Fundamentals of Food Engineering	3(2+1)
10.	FPE 3108 Food Storage Engineering	3 (2+1)
11.	FPE 3209 Food Refrigeration and Cold Chain	3 (2+1)
12.	FPE 4110 Food Process Equipment Design	3 (2+1)
Elective courses		
1.	EFE 4101 Food Plant Design and Layout	3 (2+1)
2.	EFE 4102 Waste and By-Products Utilization	3 (2+1)
Skill Enhancement Courses		
1.	SFE --01 Introduction to Electrical and Control Systems in the Food Industry	2 (0+2)

2.	SFE --02 Introduction to Mechanical Systems in Food Industry	2 (0+2)
3.	SFE --03 Introduction to AutoCAD	2 (0+2)
Department of Food Safety and Quality Assurance		
1.	FSQ 1101 General Microbiology	3 (2+1)
2.	FSQ 1202 Food Chemistry I	3 (2+1)
3.	FSQ 2103 Food Chemistry II	3 (2+1)
4.	FSQ 2104 Food Microbiology	3 (2+1)
5.	FSQ 2205 Food Plant Sanitation	3 (2+1)
6.	FSQ 2206 Food Quality, Safety Standards and Certification	2 (2+0)
7.	FSQ 3107 Food Biochemistry and Nutrition	3 (2+1)
8.	FSQ 3208 Food Additives and Preservatives	2 (1+1)
Elective Courses		
1.	EFS 4101 Industrial Microbiology	3 (2+1)
2.	EFS 4102 Introduction to Food Biotechnology	3 (2+1)
3.	EFS 4103 Instrumental Techniques in Food Analysis	3 (2+1)
Skill Enhancement Courses		
1.	SFS --01 Introduction to Food Safety and Sanitation	2 (0+2)
2.	SFS --02 Introduction to Good Laboratory Practices	2 (0+2)
3.	SFS --03 Basic Food Analysis Laboratory Techniques	2 (0+2)
Department of Food Plant Operations		
1.	FPO 2201 Food Plant Utilities and Services	3 (2+1)
Skill Enhancement Courses		
1.	SFP --01 Maintenance of Food Processing Equipment	2 (2+0)
2.	SFP --02 Introduction to Bottling and Canning Line	2 (2+0)
3.	SFP --03 Introduction to Manufacturing of Bakery Products	2 (2+0)
Internship		
1.	IFP 1201 Internship (only for exit option for award of UG-Certificate) (10 weeks)	10 (0+10)
2.	IFP 2202 Internship (only for exit option for award of UG- Diploma) (10 weeks)	10 (0+10)
3.	IFP 4203 Student Ready / Internship (at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)
Department of Basic Engineering and Applied Sciences		
1.	BES 1115 Farming Based Livelihood System	3 (2+1)
2.	BES 1116 Communication Skills	2 (1+1)
3.	BES 2117 Basic Electronic Engineering	2 (1+1)
4.	BES 2118 Engineering Mathematics- I	2 (2+0)
5.	BES 2119 Agricultural Informatics and Artificial Intelligence	3 (2+1)
6.	BES 2220 Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)
7.	BES 2221 Engineering Mathematics- II	2 (2+0)

8.	BES 2222 Entrepreneurship Development and Business Management	3 (2+1)
9.	BES 2223 Personality Development	2 (1+1)
10.	BES 3124 Project Preparation and Management	2 (1+1)
11.	BES 3125 Agricultural Marketing and Trade	3 (2+1)
12.	BES 4126 ICT Applications in Food Industry	3 (1+2)
Elective Courses		
1.	EBE 4108 Business Management and Economics	2 (2+0)
2.	EBE 4109 Statistical Methods and Numerical Analysis	2 (1+1)
3.	EBE 4110 Instrumentation and Process Control in Food Industry	3 (1+2)
Common courses		
1.	CFT 1101 *Deeksharambh* (Induction-cum-Foundation Course (2 weeks)	2 (0+2) (NG)
2.	CFT 1102 NSS-I	1 (0+1)
3.	CFT 1103 NCC-I	1 (0+1)
4.	SWC 1208 Environmental Studies and Disaster Management	3 (2+1)
5.	CFT 1204 NSS-II	1 (0+1)
6.	CFT 1205 NCC-II	1 (0+1)

Summary of Credit Distributions

S. No.	Categories of Courses	Credit Hours
1.	Core Courses (Major and Minor)	116
2.	Common Courses (MDC+VAC+AEC)	23
3.	Skill Enhancement Courses (SEC)	12
4.	Internship	20
5.	*Deeksharambh* (Non-gradial)	2*
6.	Study tour (Non-gradial)	2*
7.	MOOCs/Online Courses (Non-gradial)	6*
Total		**171+2*+2*+6***

*Non-gradial

Credits Allocation Scheme of UG Program B.Tech. (Food Technology) (Credit Hours)

Semester	Core Courses (Major + Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	$3^{(2)}$	-	$1^{(3)}$ + $2^{(4)}$	4	-	22	$2^{(1)}$	-	6
II	15	-	$3^{(6)}$	$1^{(3)}$	4	-	23	-	$10^{(12)}$	
III	16	-	$3^{(10)}$	$2^{(8)}$	2	-	23	-	-	
IV	13	$3^{(5)}$	-	$2^{(7)}$	2	-	20	-	$10^{(13)}$	
V	19	$3^{(9)}$	-	-	-	-	22	$2^{(11)}$	-	
VI	21	-	-	-	-	-	21	-	-	
VII	20	-	-	-	-	-	20	-	-	
VIII	-	-	-	-	-	20	20	-	-	
Total	**116**	**9**	**6**	**8**	**12**	**20**	**171**	**4**		**6**

Note: The credit hours mentioned in the table includes both theory and practical.
(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems.
(3) NCC/NSS.
(4) Communication Skills.
(5) Entrepreneurship Development and Business Management.
(6) Environmental Studies and Disaster Management.
(7) Personality Development.
(8) Physical Education, First Aid, Yoga Practices and Meditation.
(9) Agriculture Marketing and Trade.
(10) Agriculture Informatics and Artificial Intelligence.
(11) Study tour (10-12 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

S. No.	Course Title	Credit Hours
1.	CFT 1101 *Deeksharambh* (Induction-cum-Foundation Course (2 weeks)	2 (0+2) Non-Gradial (NG)
2.	FPT 1101 Fundamentals of Food Processing	3 (2+1)
3.	FMP 1114 Workshop Technology	3 (1+2)
4.	FMP 1115 Basic Electrical Engineering	3 (2+1)
5.	FSQ 1101 General Microbiology	3 (2+1)
6.	BES 1115 Farming Based Livelihood System	3 (2+1)
7.	BES 1116 Communication Skills	2 (1+1)
8.	CFT 1102 NSS-I / CFT 1103 NCC-I	1 (0+1)
9.	Skill Enhancement Course - I*	2 (0+2)
10.	Skill Enhancement Course - II*	2 (0+2)
Total		**22 (10+12) + 2 (NG)**

CFT 1101 *Deeksharambh* (Induction-cum-Foundation Course) 2(0+2) NG

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to:

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

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

- Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University.
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences.
- Students shall be made aware about the field of food processing, the industry, production systems, importance of nutrition, packaging, quality issues involved, shelf life and the legal standards available using simple day to day examples.
- In addition, the students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that are existing in this area of food processing technology.
- The students will be encouraged to develop deep interest in the field in which now they have entered. It will also make it clear about the skill enhancement courses that they need to choose during the study to decide their future.

- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences.
- Activities to enhance cultural Integration of students from different backgrounds.
- Field visits to related fields/ establishments.
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.

FPT 1101 Fundamentals of Food Processing 3 (2+1)

Objectives

1. Gain an understanding of the perishability of food and causes for food spoilage.
2. Have an idea of the basic methods of preservation of food.
3. Knowledge about non-thermal processing of food.

Theory

Module I **(9 Hours)**

Food: Definition, functions, classification of foods, sources, types, perishability of foods; Spoilage: causes and types of food spoilage, scope and benefit of food preservation; Food processing: Introduction, levels and techniques; Methods of food preservation: Preservation by salt and sugar, principle, method and effect on food quality.

Module II **(9 Hours)**

Preservation by heat treatment: principle, process and equipment for blanching, canning, pasteurization, sterilization; Preservation by use of low temperature: principle, methods, equipment; preservation by drying, dehydration and concentration: principle, methods, equipment.

Module III **(6 Hours)**

Preservation by irradiation: principle, methods, equipment; Preservation by chemicals: antioxidants, mould inhibitors, antibodies, acidulants, hurdle technology; Preservation by fermentation: principles, methods, equipment.

Module IV **(10 Hours)**

Non-thermal preservation processes: principles, equipment, pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology; Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage, Blanching of selected food items, Preservation of food by heat treatment- pasteurization, Preservation of food by high concentration of sugar: Jam, Preservation of food by using salt: Pickle, Preservation of food by using acidulants: pickling by acid, vinegar or acetic acid, Preservation of food by using

chemical preservatives, Preservation of bread, cake using mould-inhibitors, Drying of fruit slices pineapple slices, apple slices in cabinet drier, Drying of green leafy vegetables, Drying of mango/other pulp by foam-mat drying, Drying of semisolid foods using roller dryers, Drying of foods using freeze drying process, Demonstration of preserving foods under cold vs. freezing process, Processing of foods using fermentation technique: preparation of sauerkraut, Study on effect of high pressure on microbes, Study on effect of pulse electric field on food.

Lecture schedule

1. Introduction-food-definition-functions.
2. Classification of foods-sources-types.
3. Perishability of foods.
4. Food spoilage-causes-types.
5. Food preservation-scope and benefits.
6. Food processing-Introduction.
7. Food processing-levels and techniques.
8. Food preservation-preservation by salt and sugar-principle-methods.
9. Food preservation-Effect on food quality.
10. Thermal preservation-principle and process.
11. Blanching-process and equipment.
12. Canning-principle, process and equipment.
13. Pasteurization-principle, process and equipment.
14. Sterilization principle, process and equipment.
15. Low temperature preservation-principle, methods.
16. Low temperature preservation-equipment.
17. Drying and dehydration-principle, methods, equipment.
18. Preservation by concentration- principle, methods, equipment.
19. Irradiation-principle, methods and equipment.
20. Preservation by chemicals-antioxidants, mould inhibitors.
21. Preservation by chemicals-antibodies, acidulants.
22. Hurdle technology-principle and process.
23. Fermentation-principles, methods and equipment.
24. Fermentation-applications in food.
25. Non-thermal preservation-principles-equipment and applications.
26. Pulsed electric field-process, equipment and applications.
27. Pulsed intense light-process, equipment and applications.
28. Ultrasound-process, equipment and applications.
29. Dielectric heating-process, equipment and applications.
30. Ohmic heating-process, equipment and applications; Infrared heating-process, equipment and applications.
31. High pressure processing-process, equipment and applications.
32. Microwave processing-process, equipment and applications.
33. Cold Plasma technology-process, equipment and applications.
34. Quality tests and shelf-life of preserved foods.

Practical Schedule

1. Demonstration of various perishable food items and degree of spoilage.
2. Blanching of selected foods.
3. Thermal preservation-pasteurization.
4. Preservation of food by high concentration of sugar: Jam.
5. Preservation of food by using salt: Pickle.
6. Preservation of food by using acidulants: pickling by acid, vinegar or acetic acid.
7. Preservation of food by using chemical preservatives.
8. Preservation of bread, cake using mould-inhibitors.
9. Drying of fruit slices pineapple slices, apple slices in cabinet drier.
10. Drying of green leafy vegetables.
11. Drying of mango/other pulp by foam-mat drying.
12. Drying of semisolid foods using roller dryers
13. Drying of foods using freeze drying process and demonstration of preserving foods under cold vs. freezing process.
14. Processing of foods using fermentation technique: preparation of sauerkraut.
15. Study on effect of high pressure on microbes and effect of pulse electric field on food.
16. Industrial visit.
17. Practical Examination.

Suggested Reading

1. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Desrosier N.W. and Desrosier, J.N. 1977. The Technology of Food Preservation. 4th edn. AVI Publishing Co., Connecticut, USA.
3. Fellows, P. 2000. Food Processing Technology: Principles and Practice. 2nd edn. CRC Press, Boca Raton, FL, USA.
4. Karel, M. and Lund, D.B. 2003. Physical Principles of Food Preservation. 2nd edn. Marcel Dekker, Inc., NY, USA.
5. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
6. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science. 5th edn. Chapman and Hall, NY, USA.
7. Rahman, M.S. 2007. Handbook of Food Preservation. 2nd edn. CRC Press, Boca Raton, FL, USA.
8. Stavros Y. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.
9. Tewari, G. and Juneja, V.K. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
10. Zeuthen, P. and Bùgh-Sùrensen, L. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.

FMP 1114 Workshop Technology 3 (1+2)

Objectives

1. Gain an understanding about different type of material and their measurement.
2. Have an idea of the basic methods involved in repair and maintenance of equipment.
3. Knowledge and skills about welding, smithy, carpentry, sheet metal, machining etc.

Theory

Module I **(4 Hours)**

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications. Safety measures in workshop; Indian Factory Acts on safety; Measuring and Gauging: Basic measuring instruments and gauges.

Module II **(4 Hours)**

Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc. Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipment; Gas welding and cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost.

Module III **(4 Hours)**

Smithy and forging: Introduction to different tools and their uses, different forging operations. Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc. Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Module IV **(4 Hours)**

Machinery: Introduction to various workshop machines: Lathe, power hacksaw, Shaper and planner, Drilling machine, Grinder and CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for shaping, slotting and planning operations, work holding and tool holding devices.

Practical

Safety and precautions to be taken in the workshop. Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry. Introduction to welding

machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipment, tools and their use; Exercises on mould making using one-piece pattern and two-piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Working on a lathe machine and study of different tools used in lathe machine. Simple exercises on turning: Step turning, taper turning, drilling and threading in lathe machine; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

Lecture Schedule

1. Introduction to engineering materials such as ferrous and non-ferrous materials and timber.
2. Introduction to engineering materials such as abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications.
3. Introduction to workshop safety measures and precautions, Indian Factory Acts on safety.
4. Introduction to basic measuring instruments and gauges.
5. Introduction to different heat treatment processes such as hardening, tempering, annealing, normalizing, etc.
6. Introduction to welding, types, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques, equipment and tools used in welding.
7. Introduction to arc welding, gas welding and cutting.
8. Introduction to soldering and brazing and their uses. Estimation of welding and soldering cost.
9. Introduction to Smithy tools and operations.
10. Introduction to various carpentry tools, materials.
11. Types of wood and their characteristics. Processes or operations in wood working.
12. Brief ideas about band saw, wooden lathe circular saw, wood planner, etc.
13. Introduction to various workshop machines such as lathe, power hacksaw, shaper, planner, drilling machines, grinder and CNC machines etc.
14. Introduction to length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances of various workshop machines.
15. Estimation of machining time for different lathe operations, shaping, slotting and planning operations.
16. Introduction to work holding and tool holding devices.

Practical Schedule

1. Introduction to workshop safety and precautions.
2. Study and identification of different materials of manufacture.
3. Study of different tools and operations used in fitting shop.
4. Study of different measuring instruments used in fitting shop.
5. Practice in sawing, filing and right-angle fitting of MS flat.
6. Introduction to operations of drilling reaming and threading with tap and dies.
7. Preparation of a paper weight.
8. Study of various carpentry tools, types of wood and their characteristics.

9. Practice in cutting, planning and working with carpentry tools.
10. Preparation of a simple cross half lap carpentry joint.
11. Preparation of a simple T-halving carpentry joint.
12. Preparation of dovetail joint in carpentry.
13. Preparation of mortise and tenon joint in carpentry.
14. Introduction to welding, types, equipment and tools used in welding.
15. Study of different types of flames used in gas welding.
16. Preparation of butt and lap joint using arc welding and gas welding.
17. Demonstration of various casting processes and equipment, tools and their use.
18. Exercises on mould making using one-piece pattern and two-piece pattern.
19. Demonstration of mould making using sweep pattern and match plate pattern.
20. Introduction to smithy and forging tools and operations.
21. Preparation of cold work job by changing mild steel round rod to square rod.
22. Preparation of cold work job by changing mild steel round rod to ring.
23. Preparation of hot work job by changing mild steel round rod to square prism.
24. Introduction to lathe machine, tools used and operations performed in machine shop.
25. Practice in simple plain turning and step turning in lathe machine.
26. Preparation of job by taper turning and drilling in lathe machine.
27. Preparation of job by knurling and threading in lathe machine.
28. Introduction to different machines in machine shop-shaper, milling machine, etc.
29. Demonstration of important operations on a shaper and milling machine.
30. Practice of changing a round MS rod into square section on a shaper.
31. Practice in making a slot, gear tooth forming and indexing.
32. Practice in bending, shaping, drawing, punching and riveting etc.
33. Practical Examination.

Suggested Readings

1. Chapman W A J. 2018. Workshop Technology (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. Elements of Workshop Technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. A Text Book of Workshop Technology. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

FMP 1115 Basic Electrical Engineering 3 (2+1)

Objectives

1. Differentiate between single and three-phase connection.
2. Have an idea on the basic measuring of electrical current and its quality.
3. Knowledge about application of wiring and connections.

Theory

Module I **(7 Hours)**

AC fundamentals: Definitions of cycle, frequency, time period, amplitude, peak value, RMS and average value, electro motive force, magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents, phase relations and vector representation, AC through resistance, inductance and capacitance, AC series and parallel circuits, simple R-L, R-C and R-L-C circuits; engineering circuit analysis: Current, voltage, power, circuit elements, Ohm's law.

Module II **(10 Hours)**

3 Phase systems: star and delta connections, relationship between line and phase voltages and currents in star and delta connections, various methods of single and three phase power measurement. Transformer: Principle of working, construction of single-phase transformer, core type, shell type transformer, EMF equation, phasor diagrams, ideal transformer, transformer on no load, transformer under load, equivalent circuits, transformer losses, efficiency, regulation, open and short circuit test.

Module III **(12 Hours)**

D.C. Machine (generator and motor): Types, construction and operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics. D.C. Motors, their starting, speed controls and characteristics. Single phase induction motor: Double field revolving theory, characteristics, phase split, shaded pole motors. Poly phase induction motor: Construction, operation, equivalent circuit, production of rotating field, effect of rotor resistance, torque equation, starting and speed control methods. Alternators: Principle of operation, types of rotors, EMF equation.

Module IV **(5 Hours)**

Electric power economics: Maximum demand charge, load factor, power factor and power factor improvement. Measuring Equipment's: Classification, characteristics of different electrical measuring systems and equipment's. Electrical wiring: system of wiring, domestic wiring installation, industrial electrification. Protection devices: Earthing, circuit protection devices, fuses, ELCB and relays.

Practical

Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a

D.C. motor. Problems on industrial electrification. Study of various circuit protection devices. Study of various measuring instruments.

Lecture Schedule

1. AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, peak value, RMS value, average value.
2. Electro motive force, magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents.
3. Phase relations and vector representation, AC through resistance, inductance and capacitance.
4. AC series and parallel circuits.
5. Simple R-L, R-C and R-L-C circuits.
6. Engineering circuit analysis: Current, voltage, power, circuit elements, Ohm's Law.
7. 3-Phase systems: Star and delta connections.
8. Relationship between line and phase voltages and currents in star and delta connections.
9. Methods of single and three phase power measurement.
10. Transformer: Principle of working, construction of single-phase transformer.
11. Core type, shell type transformer.
12. EMF equation, phasor diagrams of transformer.
13. Ideal transformer, transformer on no load.
14. Transformer under load, equivalent circuits.
15. Transformer losses, efficiency, regulation.
16. Open and short circuit test of transformer.
17. D.C. machine (generator and motor): Types, construction.
18. Operation, EMF equation of D.C motor.
19. Armature reaction, commutation of D.C. generator.
20. Characteristics D.C motor; D.C. motors starting.
21. Speed controls and characteristics of DC motors.
22. Single phase induction motor.
23. Double field revolving theory.
24. Characteristics, phase split, shaded pole motors.
25. Poly phase induction motor: construction, operation.
26. Equivalent circuit of induction motor.
27. Production of rotating field, effect of rotor resistance.
28. Torque equation, starting of induction motor.
29. Speed control method of induction motor.
30. Alternators: Principle of operation, types of rotors, EMF equation.
31. Electric power economics: Maximum demand charge, load factor, power factor and power factor improvement.
32. Measuring equipment: Classification, characteristics of different electrical measuring systems and equipment.
33. Electrical wiring: System of wiring, domestic wiring installation, industrial electrification.
34. Protection devices: Earthing, circuit protection devices, fuses, ELCB and relays.

Practical Schedule

1. Study of voltage resonance in L.C.R. circuits at constant frequency: Star connection study of voltage and current relation.
2. Study of voltage resonance in L.C.R. circuits at constant frequency: Delta connection study of voltage and current relation.
3. Measurement of Power in 3 phase circuit by wattmeter and energy meter for balanced loads.
4. Measurement of Power in 3 phase circuit by wattmeter and energy meter for unbalanced loads.
5. OC and SC load test, efficiency and regulation test of single-phase transformer.
6. Starting of induction motors by D.O.L.
7. Starting of induction motors by Manual star delta.
8. Starting of induction motors by Automatic star delta starts.
9. Starting of slip ring induction motors by normal and automatic rotor resistance starters.
10. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs.
11. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator.
12. Magnetization characteristics of D.C. generator.
13. Study the starter connection and starting reversing and adjusting speed of a D.C. motor.
14. Problems on Industrial Electrification.
15. Study of various circuit protection devices.
16. Study of various measuring instruments.
17. Practical Examination.

Suggested Reading

1. Theraja, B.L. and Theraja, A.K. 2005. A Textbook of Electrical Technology. Vol. II. S. Chand and Company Ltd., New Delhi.
2. Toro, V.D. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.
3. Dr. P.S. Bimbhra. 2004. Electrical Machinery, Khanna Publications, New Delhi.
4. Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.
5. Robert L Smith and Stephen L Herman. 2011. Electrical Wiring – Industrial.

FSQ 1101 General Microbiology 3 (2+1)

Objectives

1. Identify the micro-organisms, their structure and growth characteristics.
2. Techniques for cultivation and preservation and control.

Theory

Module I **(12 Hours)**

Scope and history of microbiology: (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.), Place of Microorganisms in living world; Groups of microorganisms; Applied area of microbiology, Classification and identification of micro- organism; Major Characteristics of Microorganisms, Methods of classification of bacteria; Microscopy: Introduction to microscope; Component of microscope; Types of microscope and Microscopic techniques.

Module II **(8 Hours)**

Microbial Ultra Structure and Functions: Morphological features; Structures external to cell wall, Cell wall; Structures internal to cell wall. Cultivation of micro-organisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for micro-organisms.

Module III **(8 Hours)**

Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: growth curve, continuous culture, synchronous culture; Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

Module IV **(6 Hours)**

Control of microorganisms: Physical and Chemical agents. Bacterial genetics. Structure and functions of DNA and RNA; Overview of replication and regulation.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule- staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: ph, temperature, growth curves for bacteria.

Lecture Schedule

1. Scope of microbiology.
2. History of microbiology-spontaneous generation theory, biogenesis, germ theory diseases.
3. History of microbiology-contributions of Leeuwenhoek, Pasteur, Koch, etc.
4. Place of Microorganisms in living world.
5. Groups of microorganisms.
6. Applied area of microbiology.
7. Classification of microorganism-general principle-three kingdom-five kingdom concept, universal phylogenetic tree.
8. Identification of microorganism-microscopy-culture.
9. Identification of microorganism-biochemical testing.

10. Major characteristics of microorganisms.
11. Methods of classification of bacteria.
12. Microscopy-introduction to microscope-components.
13. Microscopy-types of microscope-microscopic techniques.
14. Microbial Ultra Structure-functions.
15. Morphological features-structures external to cell wall-cell wall.
16. Morphological features- structures internal to cell wall.
17. Cultivation of micro-organisms.
18. Nutritional requirements.
19. Preservation of micro-organisms.
20. Types of media.
21. Physical condition required for the growth.
22. Enumeration methods for micro-organisms.
23. Bacterial metabolism and growth.
24. Reproduction of bacteria.
25. Growth of bacteria-growth curve-continuous culture.
26. Growth of bacteria-synchronous culture.
27. Methods of isolation of pure cultures.
28. Maintenance and preservation of pure cultures.
29. Culture collections-culture collection in microbiology.
30. Control of microorganisms-physical agents.
31. Control of microorganisms-chemical agents.
32. Bacterial genetics-structure and functions of DNA and RNA.
33. Overview of replication and regulation.
34. Overview of replication and regulation.

Practical Schedule

1. Microscopy and Micrometry.
2. Cleaning and sterilization of glassware.
3. Equipment used in microbiology.
4. Preparation of nutrient agar media and techniques of inoculation.
5. Staining methods-simple (monochrome) staining and negative staining.
6. Gram staining.
7. Capsule-staining-endospore staining-flagella staining.
8. Pure culture techniques-streak plate.
9. Pure culture techniques-pour plate.
10. Pure culture techniques-spread plate.
11. Identification procedures for unknown bacteria-morphological characteristics.
12. Identification procedures for unknown bacteria-cultural characteristics.
13. Growth characteristics of fungi.
14. Determination of microbial numbers-direct plate count-generation time.
15. Factors influencing growth-pH, temperature.
16. Growth curves for bacteria.
17. Practical examination.

Suggested Reading

1. Pelczar JR. M.J., Chan, E.C.S. and Krieg, N.R. 1998. Microbiology. 5th edn. Tata Mcgraw-Hill Education, New Delhi.
2. Tortora, G.J., Funke, B.R. and Case, C.L. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
3. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th edn. Mcgraw-Hill Higher Education, NY, USA.

BES 1115 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

Module I **(12 Hours)**

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.

Module II **(12 Hours)**

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.

Module III **(4 Hours)**

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.

Module IV **(6 Hours)**

Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing lifestyle.

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.

Lecture Schedule

1. Introduction to agriculture in India.
2. Status of agriculture in different states of India.
3. Income of farmers and rural people in India.
4. Livelihood- definitions, concepts, and frameworks.
5. Livelihood patterns in urban and rural areas- a comparative analysis.
6. Indicators for studying livelihood systems.
7. Agricultural Livelihood Systems (ALS)-meaning and approaches.
8. Approaches and frameworks of ALS.
9. Definition and importance of farming systems and farming based livelihood systems.
10. Prevalent farming systems in India.
11. Traditional farming systems in India-types.
12. Modern farming systems in India- types.
13. Components of farming-based livelihood systems.
14. Crop-based livelihood systems.
15. Crops and cropping systems-importance in farming livelihoods.
16. Livestock-based livelihood systems-dairy, piggery, goatry, poultry, duckry etc.
17. Horticultural crops in livelihood systems.
18. Agro-forestry systems.
19. Aqua culture-based systems.
20. Duck/poultry cum fish, dairy cum fish, piggery cum fish.
21. Small enterprises as livelihood components.
22. Medium enterprises-value chains and secondary enterprises as livelihood components.
23. Large enterprises-value chains and secondary enterprises as livelihood components for farmers.
24. Integration of farming and non-farming enterprises- benefits and factors affecting.
25. Feasibility of different farming systems for different agro-climatic zones.
26. Zone-specific farming systems.
27. Commercial farming-based livelihood models-NABARD, ICAR and other organizations.
28. Case studies on different livelihood enterprises across country.
29. Risk and success factors in farming-based livelihood systems.
30. Schemes and programs by central and state government.

31. Schemes and programs by public and private organizations in promotion of farming-based livelihood opportunities.
32. Role of farming-based livelihood enterprises in 21st century in view of circular economy.
33. Role of farming-based livelihood enterprises in 21st century in view of green economy, climate change etc.
34. Role of farming-based livelihood enterprises in 21st century in view digitalization and changing lifestyle.

Practical Schedule

1. Survey of farming systems and agricultural-based livelihood enterprises.
2. Survey of farming systems and agricultural-based livelihood enterprises.
3. Study of components of farming-based livelihood models in different agroclimatic zones.
4. Study of components of farming-based livelihood models different agroclimatic zones.
5. Study of production and profitability of crop-based livelihood models.
6. Study of production and profitability of livestock-based livelihood models.
7. Study of production and profitability of processing-based livelihood models.
8. Study of integrated farming-based livelihood models.
9. Field visit to innovative farming system models-preparation.
10. Reflection and analysis of field visit- group discussion.
11. Field visit- farming system models.
12. Visit to agri-based enterprises.
13. Study the functional aspects of agri-based enterprises for the integration of production, processing and distribution sectors.
14. Study of agri-enterprises involved in industry and service sectors-value chain models.
15. Learning the concept of project formulation on farming-based livelihood systems.
16. Study of the cost and profit analysis of farming-based livelihood systems.
17. Case study of start-ups in agri-sectors.

Suggested Reading

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C., 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 A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington DC, USA.
5. Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries. In FAO, The State of Food and Agriculture, FAO, Rome, Italy.
6. Bhatt, B. P., Kumar, A., Thakur P. K., Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B. K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh.

Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by ICAR Research Complex for Eastern Region, ICAR Parisar P. O., Bihar Veterinary College, Patna-800014, Bihar.
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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.

BES 1116 Communication Skills 2(1+1)

Objectives

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

Theory

Module I **(3 Hours)**

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.

Module II **(5 Hours)**

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.

Module III **(10 Hours)**

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.

Lecture Schedule

1. Communication process-the magic of effective communication-building self-esteem-overcoming fears.
2. Communication process-concept, nature and significance.
3. Meaning, types, and models of communication-verbal and non-verbal communication.
4. Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.
5. Basic communication skills-listening-speaking-reading-writing skills.
6. Precis writing/abstracting/summarizing.
7. Style of technical communication-curriculum vitae/resume writing.
8. Innovative methods to enhance vocabulary, analogy questions.
9. Structural and functional grammar-sentence structure.
10. Grammar-modifiers, connecting words and verbals.
11. Grammar-Phrases and clauses.
12. Case-subjective case-possessive case-objective case.
13. Correct usage of nouns-pronouns.
14. Correct usage of antecedents-adjectives-adverbs-articles.
15. Agreement of verb with the subject-tenses-mood-voice.
16. Writing effective sentences.
17. Basic sentence faults.

Practical Schedule

1. Listening and notetaking.
2. Writing skills-precis writing.
3. Summarizing and abstracting.
4. Reading and comprehension of general articles-written and oral.
5. Reading and comprehension of technical articles-written and oral.
6. Micro-presentations.
7. Micro-presentations.
8. Impromptu Presentations.
9. Impromptu Presentations.
10. Feedback on presentations-stage manners-grooming-body language-voice modulation-speed.
11. Group discussions.
12. Public speaking exercises.
13. Public speaking exercises.
14. Vocabulary building exercises.
15. Vocabulary building exercises
16. Interview techniques.
17. Organization of events.

Suggested Reading

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

CFT 1102 NSS-I 1(0+1)

Objectives

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

Practical/ Awareness activities

- Orientation-history, objectives, principles, symbol, badge-regular programs under NSS.
- Organizational structure of NSS-code of conduct for NSS volunteers-points to be considered by NSS volunteer's awareness about health.
- NSS programme activities-concept of regular activities-special camping-day camps-basis of adoption of village/slums-conducting survey-analysing/guiding financial patterns of scheme, youth programs/schemes of GoI-Coordination with different agencies and maintenance of diary.
- Understanding youth-definition, profile-categories-issues and challenges of youth-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-human rights-basic features of constitution of India-fundamental rights and duties-human rights-consumer awareness and rights-rights to information.
- Family and society-concept of family, community and society-PRIs and other community-based organizations.

CFT 1103 NCC-I 1(0+1)

Objectives

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

Practical/ Awareness activities

- Aims-objectives-organization of NCC and NCC song-DG's cardinals of discipline.
- Drill- aim-general words of command-attention, stands at ease-stand easy and turning.
- Sizing-numbering-forming in three ranks-open and close order march-dressing.
- Saluting at the halt-getting on parade-dismissing-falling out.
- Marching-length of pace-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-squad drill.
- Command and control-organization-badges of rank-honours-awards.
- Nation Building-cultural heritage-religions-traditions-customs of India-National integration-values and ethics-perception-communication-motivation-decision making-discipline-duties of good citizens.
- Leadership traits-types of leadership-character/personality development-civil defence organization-types of emergencies-fire-fighting-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.

Semester II

Semester II		
S. No.	**Course Title**	**Credit Hours**
1.	FPE 1201 Post-Harvest Engineering	3 (2+1)
2.	FSQ 1202 Food Chemistry I	3 (2+1)
3.	FPE 1202 Unit Operations in Food Processing	3 (2+1)
4.	FPE 1203 Food Thermodynamics	3 (2+1)
5.	FPE 1204 Engineering Drawing and Graphics	3 (1+2)
6.	SWC 1208 Environmental Studies and Disaster Management	3 (2+1)
7.	CFT 1204 NSS-II / CFT 1205 NCC-II	1 (0+1)
8.	Skill Enhancement Course - III*	2 (0+2)
9.	Skill Enhancement Course - IV*	2 (0+2)
Total		**23 (11+12)**

FPE 1201 Post Harvest Engineering 3(2+1)

Objectives

1. To understand the basic post-harvest operations.
2. Gain an understanding of various engineering properties.
3. Differentiate between different types of material handling systems.

Theory

Module I **(12 Hours)**

Overview of post-harvest technology; Concept and science, introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses, reasons for losses, importance of loss reduction, post-harvest handling operations. Water activity; Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture. Engineering properties of food materials; physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement. Cleaning; Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling, sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance.

Module II **(8 Hours)**

Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator. Decorticating and shelling; Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc. Milling, polishing, grinding, milling equipment,

de-huskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement.

Module III **(7 Hours)**

Materials Handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices. Study of different Material Handling systems; Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain.

Module IV **(7 Hours)**

Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement; Pneumatic conveying system: types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Lecture Schedule

1. Overview of post-harvest technology-concept and science.
2. Introduction to different agricultural crops-cropping pattern-production status.
3. Harvesting and post-harvest losses-reasons for losses-importance of loss reduction.
4. Post-harvest handling operations.
5. Water activity-water binding-effect on enzymatic and non-enzymatic reactions-food texture-control of water activity and moisture.
6. Engineering properties of food-physical and thermal properties-their measurement.
7. Engineering properties-aerodynamic and optical properties.
8. Engineering properties-mechanical-rheological-electromagnetic properties.
9. Cleaning-cleaning of grains-washing of fruits and vegetables-types of cleaners-screens-types of screens-rotary screens-vibrating screens.
10. Machinery for cleaning of fruits and vegetables-air cleaners-washers-cleaning efficiency-care and maintenance.

11. Peeling-sorting-grading-methods of grading-size grading-colour grading-specific gravity grading-screening.
12. Equipment for grading of fruits and vegetables-grading efficiency-care and maintenance.
13. Separation-magnetic separator-destoners-electrostatic separators-pneumatic separator.
14. Decorticating and shelling-principles of working-design and construction.
15. Operating parameters-maintenance of various decorticators/dehullers/shellers.
16. Description of groundnut decorticators-maize shellers.
17. Milling-grinding-milling equipment-de-huskers-deshelling machines.
18. Polishers-abrasion-friction-water jet-flour milling machines.
19. Pulse milling machines-grinders-cutting machines-machine efficiency-power requirement.
20. Oil expellers-machine efficiency and power requirement.
21. Materials handling-introduction to different conveying equipment.
22. Scope and importance of material handling devices.
23. Study of different material handling systems-classification-principles of operation-conveyor system selection/design.
24. Belt conveyor-principle-characteristics-design-relationship between belt speed and width-capacity.
25. Inclined belt conveyors-idler spacing-belt tension-drive tension-belt tripper.
26. Chain conveyor-principle of operation-advantages-disadvantages.
27. Capacity and speed-conveying chain.
28. Screw conveyor-principle of operation-capacity-power-troughs-loading and discharge.
29. Inclined and vertical screw conveyors.
30. Bucket elevator-principle-classification-operation-advantages-disadvantages.
31. Capacity-speed-bucket pickup-bucket discharge.
32. Relationship between belt speed-pickup and bucket discharge-buckets types-power requirement.
33. Pneumatic conveying system-types-air/product separators.
34. Gravity conveyor-design considerations-capacity and power requirement.

Practical Schedule

1. Determination of physical properties of food-shape-size-bulk density-porosity.
2. Determination of angle of repose and coefficient of friction of grains.
3. Determination of terminal velocity of grains.
4. Study and performance of cleaners for grains.
5. Study of washers for fruits and vegetables.
6. Study of graders for grains, fruits and vegetables.
7. Study of decorticators, study of a maize/ sunflower sheller.
8. Study of a RF/MW/tray dryer.
9. Study of hot air dryer, vacuum dryer and modelling drying kinetics.
10. Study of working principle of spray dryer and spray drying process.
11. Study of drum dryer and liquid food dehydration using drum drying.
12. Study of fluidized bed dryer and drying process.
13. Study of freeze dryer and freeze-drying process.

14. Study of rice milling machines.
15. Study of different components of flour mill.
16. Study of different materials handling equipment.
17. Practical examination.

Suggested Reading

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
3. Chakraverty, A. 2008. Post-harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Chakraverty, A. and Singh, R.P. 2014. Post-harvest Technology and Food Process Engineering, CRC Press, Boca Raton, FL, USA.
5. Dash, S K, Bebartta, J P and Kar, A. 2012. Rice Processing and Allied Activities. Kalyani Publishers.
6. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
7. Green, D.W. and Perry, R.H. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
8. Hall, C. W. and Davis, D. C. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. Henderson, S.M. and Perry, R.L. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.
10. Mohsenin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York
11. Mohsenin, N.N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
12. Mohsenin, N.N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, NY.
13. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
14. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

FSQ 1202 Food Chemistry I 3(2+1)

Objectives

1. Learn the chemical aspects of food and biomaterials and its importance in food processing.
2. Gain an understanding of water and macro-molecules.
3. Have an idea of about the effect of processing on these biomolecules.

Theory

Module I **(8 hours)**

Water; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems.

Module II **(7 hours)**

Carbohydrates; Monosaccharaides, disaccharides and polysaccharides, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates.

Module III **(7 hours)**

Proteins in foods: Proteins: Classification, structure and properties, Proteins and nutrition, Functional properties of proteins, Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein.

Module IV **(12 hours)**

Lipids in foods: Classification, structure and properties of lipids; Role and use of lipids/ fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, use of oils and fats in food formulation. Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques, chemical aspects of lipids, antioxidants.

Practical

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases.

Lecture Schedule

1. Water-moisture in foods-role and types of water in foods.
2. Functional properties of water.
3. Water activity and sorption isotherm.
4. Molecular mobility and foods stability.
5. Dispersed systems of foods: Physicochemical aspects of food dispersion system.
6. Dispersed systems of foods: Sol, gel, foam, emulations.
7. Rheology of diphase systems.
8. Carbohydrates-monosaccharaides.
9. Carbohydrates-disaccharides.

10. Carbohydrates-polysaccharides.
11. Modification of carbohydrates.
12. Dietary fibres.
13. Carbohydrates digestibility.
14. Enzymatic and chemical reactions of carbohydrates.
15. Proteins in foods-classification.
16. Proteins in foods-structure and properties.
17. Proteins and nutrition.
18. Functional properties of proteins.
19. Processing induced, physical, chemical changes in protein.
20. Processing induced nutritional changes in protein.
21. Chemical and enzymatic modification of protein.
22. Lipids in foods-classification.
23. Structure and properties of lipid.
24. Role and use of lipids/fat.
25. Role and use of lipids/fat-crystallization and consistency.
26. Chemical aspects of lipids.
27. Lipolysis-auto-oxidation.
28. Thermal decomposition-chemistry of frying technology of fat and oil.
29. Oil processing-refining-hydrogenations-inter esterification.
30. Use of oils and fats in food formulation.
31. Enzymatic and chemical reactions of fats.
32. Enzymatic and chemical reactions of fats-rancidity and its types
33. Detection techniques, chemical aspects of lipids.
34. Antioxidants.

Practical Schedule

1. Determination of moisture content of foods using different methods.
2. Studies of sorption isotherms of different foods.
3. Swelling and solubility characteristics of starches.
4. Rheological properties of food systems.
5. Determination of crude proteins by micro-Kjeldhal method.
6. Determination of essential amino acids-Lysine.
7. Determination of essential amino acids-Tryptophan.
8. Determination of essential amino acids-Methionine.
9. Isolation of egg and milk protein.
10. Preparation of protein isolate and concentrate of proteins.
11. Determination of acid value of fat/oil.
12. Saponification value of fat/oil.
13. Iodine Number of fat/oil.
14. Assay of amylases.
15. Assay of papain.
16. Assay of lipases.
17. Practical examination.

Suggested Reading

1. Brady, J.W. 2013. Introductory food chemistry. Comstock publishing associates, Cornell university press, Ithaca, USA.
2. Belitz, H. D., Grosch, W. and Schieberle, P. 2009. Food chemistry, 4th Edn. Springer-Verlag, Berlin, Heidelberg.
3. Fennema, O.R. 1996. Food chemistry, 3rd Edn. Marcel Dekker Inc., New York, USA.
4. Meyer, L.H. 1974. Food chemistry. The AVI publishing Co. Inc., connecticut, MA, USA.

FPE 1202 Unit Operations in Food Processing 3 (2+1)

Objective

1. To familiarize with Commonly involved unit operations in food processing
2. Differentiate between blanching, pasteurization and sterilization
3. Application of these unit operations in food product development.

Theory

Module I **(8 Hours)**

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation. Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices.

Module II **(9 Hours)**

Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.

Module III **(8 Hours)**

Expression and extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations. Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization. Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation,

distillation of wines and spirits. Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment. Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment.

Module IV **(9 Hours)**

Puffing: Puffing methods, puffing equipment. Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger. Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package. Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification

Practical

Study of working principle open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar. Study of freezers/ Design problems on freezers; To study freezing of foods by different methods IQF freezing; Determination of freezing time of a food material; To study simple distillation process and determine the rate of distillation; To study the process of roasting/ To study the effect of time temperature combination on roasting; Determination of oil uptake by the food product during frying. To determine the efficacy of a blanching process; time-temperature combination for a blanching process; efficacy of a sterilization process; Determination of F value for a product in can/ retortable pouch; Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators.

Lecture Schedule

1. Evaporation-principles-mass and energy balance-factors affecting rate of evaporation.
2. Thermodynamics of evaporation-phase change-boiling point elevation-Dühring plot-heat and mass transfer in evaporator.
3. Factors influencing the overall heat transfer coefficient-influence of feed liquor properties.
4. Evaporation equipment-natural circulation evaporators-horizontal/vertical short tube-natural circulation with external calandria-long tube-forced circulation.
5. Evaporator ancillary plant-design of evaporation systems-single effect-multiple effect evaporators.
6. Feeding methods of multiple effect evaporation systems-feed preheating-vapour recompression systems.
7. Fouling of evaporators and heat exchangers-recompression heat and mass recovery-vacuum creating devices.

8. Food freezing-introduction-freezing point curve for food and water-freezing points of common food materials.
9. Principles of food freezing-freezing time calculation by using Plank's equation.
10. Freezing systems-direct contact systems-air blast-immersion.
11. Changes in foods-frozen food properties.
12. Freezing time-factors influencing freezing time-freezing/thawing time.
13. Freeze concentration-principles-process-methods-frozen food storage.
14. Quality changes in foods during frozen storage.
15. Freeze drying-heat mass transfer during freeze drying-equipment and practice.
16. Expression and extraction-liquid-liquid extraction processes-types of equipment-design for liquid-liquid extraction.
17. Continuous multistage counter current extraction.
18. Leaching-process-preparation of solids-rate of leaching-types of equipment-equilibrium relations.
19. Crystallization-theory and principles-kinetics-applications in food industry-equipment for crystallization.
20. Dissolution-theory and principles-kinetics-applications in food industry-equipment.
21. Distillation-principles-vapour-liquid equilibrium-continuous flow distillation-batch/ differential distillation.
22. Fractional distillation-steam distillation-distillation of wines and spirits.
23. Baking-principles-baked foods-baking equipment.
24. Roasting-principles of roasting-roasting equipment.
25. Frying-theory and principles-shallow or contact frying and deep fat frying.
26. Heat and mass transfer in frying-frying equipment.
27. Puffing-puffing methods-puffing equipment.
28. Blanching-principles and equipment.
29. Pasteurization-purpose, microorganisms and their reaction to temperature.
30. Methods of heating-design and mode of operation of heating equipment-vat-tubular heat exchanger-plate heat exchanger.
31. Sterilization-principles-process time-T-evaluation-design of batch and continuous sterilization-different methods and equipment.
32. UHT sterilization-in the package sterilization-temperature and pressure patterns-equipment for sterilizing goods in the package.
33. Aseptic processing-principles-analysis of thermal resilience-duration mathematics of conduction heating.
34. Thermal processing-microbial death curves-homogenization-emulsification.

Practical Schedule

1. Study of working principle of open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods.
2. Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods.
3. Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods.

4. Effect of sample particle size and time on solvent extraction process.
5. Effect of temperature on crystallization rate of sugar.
6. Study of freezers/ design problems on freezers.
7. To study freezing of foods by different methods IQF freezing.
8. Determination of freezing time of a food material.
9. To study simple distillation process and determine the rate of distillation.
10. To study the process of roasting/ to study the effect of time temperature combination on roasting.
11. Determination of oil uptake by the food product during frying.
12. To determine the efficacy of a blanching process; time-temperature combination for a blanching process.
13. Efficacy of a sterilization process.
14. Determination of F value for a product in can/ retortable pouch.
15. Study of ultra-filtration and membrane separation process.
16. Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators.
17. Practical Examination.

Suggested Reading

1. Earle, R.L. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science and Technology, New Zealand.
2. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd edn. CRC Press, Boca Raton, FL, USA
3. Geankoplis, C.G. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
4. Ibarz, A. and Barbosa-Cánovas, G. V. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
5. McCabe, W.L., Smith, J. and Harriott, P. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
6. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth– Heinemann, Oxford, UK.
8. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.
9. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
10. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
11. Treybal, R.E. 1980. Mass Transfer Operations, 3rd edn. McGraw-Hill Book Company, Auckland, USA.
12. Valentas, K.J., Rotstein, E. and Singh, R.P. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

FPE 1203 Food Thermodynamics 3(2+1)

Objectives

1. Have an idea about basic concepts of energy and laws of thermodynamics.
2. Knowledge about thermodynamic cycles and their application.
3. Knowledge about psychrometric properties of air and its application in drying and other food applications.

Theory

Module I **(8 Hours)**

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat.

Module II **(6 Hours)**

First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, entropy, availability and irreversibility.

Module III **(7 Hours)**

Properties of pure substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle.

Module IV **(13 Hours)**

Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms. Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity. Boilers and steam generation: fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Practical

Demonstration and application of zeroth law of thermodynamics; first law of thermodynamics; and second law of thermodynamics. Study of different types of boilers; boiler mounting and accessories; various types of burners and fuels; Determination of calorific values of different fuels. Study of vapour compression refrigeration test rig; heat pump; properties of wet, dry, saturated and superheated steam; Use of steam tables and Mollier charts; Dryness fraction of steam; Use of psychometric chart for humidification, dehumidification, heating and drying;

Determination of thermodynamic properties on psychrometric charts; Study of steam trap and steam line layouts; Visit to food plant with steam utilization.

Lecture Schedule

1. Basic concepts-definitions-approaches-thermodynamic systems.
2. Concept of continuum-state and properties of system-thermodynamic properties.
3. Extensive and intensive properties-specific weight and volume-pressure-expression in various units.
4. Concept of equilibrium-path-process-cyclic process-quasi static process.
5. Equilibrium-state of a system-state diagram-path and process-different modes of work.
6. Zeroth law of thermodynamics-concept of temperature-heat and temperature scales.
7. Pdv work-path function-heat and flow work.
8. Heat-specific heat-perfect gas and gas laws-Boyle's law, Charle’s law.
9. First law of thermodynamics-energy-enthalpy-specific heats-applications of first law-steady and unsteady flow analysis.
10. Internal energy-enthalpy-specific heat-heat and work-steady flow process.
11. Conservation of energy-non flow systems-isometric-isobaric processes-isothermal and polytropic processes.
12. Constant internal energy process-steady flow process-energy equation.
13. Second law of thermodynamics-Kelvin-Planck and Clausius statements-reversible and irreversible processes.
14. Entropy-availability and irreversibility.
15. Properties of pure substances-thermodynamic properties of pure substances in solid, liquid and vapour phases.
16. Entropy changes during isobaric and isometric processes.
17. Entropy changes during isothermal and polytropic processes.
18. Temperature entropy diagram-principle of entropy change-concepts on entropy- examples explaining entropy change.
19. P-V-T behaviour of simple compressible substances-phase rule.
20. Thermodynamic cycles-Carnot vapor power cycle-ideal Rankine cycle.
21. Thermodynamic cycles-air standard Otto cycle-air standard Diesel cycle-vapor compression refrigeration cycle.
22. Psychometry-thermodynamic properties of moist air-perfect gas relationship.
23. Psychrometry properties of air-absolute humidity-relative humidity-percentage humidity-humid volume-total heat-enthalpy-dry bulb temperature-wet bulb temperature-dew point temperature-adiabatic processes-wet bulb depression-humid heat-specific volume.
24. Psychrometric processes- heating-cooling-dehumidifying-sorption isotherms.
25. Psychrometric problems.
26. Three stages of water-phase diagram for water-vapor pressure-temperature curve for water-heat requirement for vaporization-measurement of humidity.
27. Boilers and steam generation-fuels for boilers and steam generation.
28. Boiler types-boiler mountings and accessories.
29. Introduction to Indian Boiler Regulation Act.
30. Layout of steam pipe-line and expansion joints.

31. Boiler draught-definition-importance and classification of draught-natural and artificial draught.
32. Calculation of height of chimney-draught analysis.
33. Properties of steam-wet, dry saturated and superheated steam.
34. Use of steam tables.

Practical Schedule

1. Study and application of zeroth law of thermodynamics-first law of thermodynamics and second law of thermodynamics.
2. Study of different types of boilers.
3. Study of boiler mounting and accessories.
4. Study of various types of burners and fuels.
5. Determination of calorific values of different fuels.
6. Study of vapor compression refrigeration test rig.
7. Study of heat pump.
8. Study of properties of wet, dry, saturated and superheated steam.
9. Study of Steam tables and its uses.
10. Study of Mollier charts and its uses.
11. Study of psychrometric chart and its properties.
12. Study of psychrometric processes.
13. Study of uses of psychometric chart for humidification, dehumidification, heating and drying.
14. Determination of thermodynamic properties on psychrometric charts.
15. Study of steam trap and steam line layouts.
16. Visit to food plant with steam utilization.
17. Practical Examination.

Suggested Readings

1. Brooker, D.B., Bakker-Arkema, F.W. and Hall, C.W. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4thedn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7thedn. McGraw-Hill, Inc., NY, USA.
4. Nag, P.K. 2005. Engineering Thermodynamics, 3rdedn. Tata-McGraw-Hill Education, New Delhi.
5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
6. Rajput, R.K. 2007. Engineering Thermodynamics, 3rdedn. Laxmi Publications (P) Ltd., Bangalore.
7. Smith, J.M., Van Ness, H.C. and Abbott, M.M. 2005. Introduction to Chemical Engineering Thermodynamics, 7th edn. McGraw-Hill, Inc., NY, USA.

FPE 1204 Engineering Drawing and Graphics 3(1+2)

Objectives

1. To gain an understanding about drawing as per engineering requirement.
2. Have an idea of the isometric, orthographic views and projection.
3. Knowledge about Computer Aided Design.

Theory

Module I **(5 Hours)**

Definition of projection, principle of projection, methods of projections, orthographic projection, plane of projection, first and third angle of projection; Different methods of dimensioning; Isometric scale, isometric axes, isometric projection, preparation of working drawing from models and isometric views; Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts.

Module II **(9 Hours)**

Types of rivet heads and riveted joints, symbols for different types of welded joints; Processes for producing leak proof joints; Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Drawing of missing views.

Module III **(3 Hours)**

Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

Practical

Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small projects using CAD/CAM.

Lecture Schedule

1. Definition of projection, principle of projection, methods of projections.
2. Orthographic projection, plane of projection, First and third angle of projection.
3. Different methods of dimensioning; Isometric scale, isometric axes, isometric projection.

4. Preparation of working drawing from models and isometric views.
5. Concept of sectioning, revolved and oblique section; Sectional drawing of simple machine parts.
6. Types of rivet heads and riveted joints.
7. Symbols for different types of welded joints.
8. Processes for producing leak proof joints.
9. Nomenclature, thread profiles, multi-start threads, left and right-hand thread.
10. Square headed and hexagonal nuts and bolts.
11. Conventional representation of threads.
12. Different types of lock nuts, foundation bolts, studs.
13. Machine screws, cap screws and wood screws.
14. Drawing of missing views.
15. Application of computers for design.
16. Definition of CAD, benefits of CAD.
17. CAD system components, computer hardware for CAD.

Practical Schedule

1. Study of lettering and exercises.
2. Introduction of drawing scales.
3. Projection-principles of orthographic projections-references planes.
4. Orthographic projections–points.
5. Orthographic projections-lines-parallel to and contained by one or both planes-perpendicular to a plane-inclined to one plane and parallel to other.
6. Projection of lines-projection of lines inclined to both plane-true length and inclination of lines-traces of lines.
7. Projection of plan-traces of planes.
8. Auxiliary planes and true shapes of oblique plane surface.
9. Auxiliary planes and true shapes of oblique plane surface.
10. Projections of solids-simple positions-change of position method- axis inclined to one plane and parallel to other-axis inclined to both planes.
11. Projection of solid-alteration of ground lines method.
12. Section of solids-interpenetration of solid surfaces.
13. Development of surfaces of geometrical solids.
14. Isometric projection of geometrical solids.
15. Isometric projection of geometrical solids.
16. Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components.
17. Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components.
18. Preparation of sectional drawings of simple machine parts.
19. Drawing of riveted joints.
20. Drawing of riveted joints.
21. Symbols for different types of welded joints.
22. Drawing of thread fasteners.

23. Drawing of thread fasteners.
24. Demonstration on computer graphics-computer aided drafting use of standard software.
25. Sectional drawings of engineering machines.
26. Computer graphics for food engineering applications.
27. Interpretation of sectional views of food equipment and components.
28. Practice in the use of basic and drawing commands on AutoCAD.
29. Practice in the use of basic and drawing commands on AutoCAD.
30. Generating simple 2-D drawings with dimensioning using AutoCAD.
31. Generating simple 2-D drawings with dimensioning using AutoCAD.
32. Small Projects using CAD/CAM.
33. Small Projects using CAD/CAM.
34. Practical Examination.

Suggested Reading

1. Bhat, N.D. and Panchal, V.M. 1995. Machine Drawing. Charotar Publishing House, Anand.
2. Bhat, N.D.1995. Elementary Engineering Drawing. Charotar Publishing House, Anand.
3. Lee, K. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.
4. Zeid, I. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.

SWC 1208 Environmental Studies and Disaster Management 3(2+1)

Objective

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

Theory

Module I **(6 Hours)**

Introduction to Environment - Environmental studies - Definition, scope, and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources - water resources - mineral resources - food resources - energy resources - land resources - soil resources.

Module II **(7 Hours)**

Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem - Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types - Biogeographical classification of India - Importance and value of biodiversity - Biodiversity hotspots - Threats and conservation of biodiversity.

Module III **(8 Hours)**

Environmental Pollution: Definition, cause, effects, and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, light pollution. Solid Waste Management: Classification of solid wastes and management methods

- Composting, incineration, pyrolysis, biogas production - Causes, effects, and control measures of urban and industrial wastes.

Module IV **(5 Hours)**

Social Issues and the Environment: Urban problems related to energy - Water conservation, rainwater harvesting, watershed management - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and Control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act.

Module V **(8 Hours)**

Human Population and the Environment: Environment and human health - Human rights, value education - Women and child welfare - Role of information technology in environment and human health. Disaster Management: Disaster definition - Types: Natural Disasters (floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves) - Man-Made Disasters (nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents) - International and national strategy for disaster reduction - Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations, and media in disaster management - Central, state, district, and local administration in disaster control; armed forces in disaster response; police and other organizations in disaster management.

Practical

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

Lecture Schedule

1. Introduction to Environmental Studies: Definition, scope, and importance. Multidisciplinary nature of environmental studies.
2. Segments of the Environment. Earth's spheres: Lithosphere, Hydrosphere, Atmosphere.
3. Different layers of the atmosphere.
4. Natural Resources: Classification and overview. Forest resources.
5. Water resources and mineral resources.
6. Food, energy, land, and soil resources.
7. Concept of an ecosystem: Definition, structure, and function.

8. Energy flow in the ecosystem. Types of ecosystems.
9. Introduction to Biodiversity: Definition and types.
10. Biogeographical classification of India.
11. Importance and value of biodiversity.
12. Biodiversity hotspots.
13. Threats to biodiversity and conservation strategies.
14. Air pollution: Definition, causes, effects, and control measures.
15. Water pollution: Definition, causes, effects, and control measures.
16. Soil pollution and marine pollution: Definition, causes, effects, and control measures.
17. Noise pollution, thermal pollution, and light pollution: Definition, causes, effects, and control measures.
18. Solid Waste Management: Classification of solid wastes.
19. Management methods: Composting, incineration, pyrolysis, biogas production.
20. Causes and effects of urban and industrial wastes.
21. Control measures for urban and industrial wastes.
22. Urban problems related to energy.
23. Water conservation, rainwater harvesting, and watershed management.
24. Environmental ethics: Issues and possible solutions.
25. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust.
26. Environmental Protection Act, Air and Water (Prevention and Control of Pollution) Acts, Wildlife Protection Act, and Forest Conservation Act.
27. Human population and environment: Health, human rights, and value education.
28. Women and child welfare, role of information technology in environment and human health.
29. Disaster Management: Definition and overview.
30. Types of natural disasters: Floods, droughts, cyclones, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.
31. Types of man-made disasters: Nuclear, chemical, biological, fires (building, coal, forest, oil).
32. Types of man-made disasters continued: Accidents (road, rail, air, sea).
33. National and international strategies for disaster reduction.
34. Disaster management framework, role of NGOs, media, community organizations.

Practical Schedule

1. Visit to a local area to document environmental assets: river, forest, grassland, hill, mountain.
2. Biogas production from organic wastes.
3. Visit to wind mill, hydro power, and solar power generation units.
4. Biodiversity assessment in farming systems.
5. Floral and faunal diversity assessment in polluted and unpolluted systems.
6. Visit to a local polluted site: Urban/Rural/Industrial/Agricultural.
7. Study of common plants, insects, and birds at the polluted site.
8. Environmental sampling and preservation.

9. Water quality analysis: pH-Electrical Conductivity (EC)-Total Dissolved Solids (TDS).
10. Estimation of acidity and alkalinity in water samples.
11. Estimation of water hardness.
12. Estimation of DO, BOD, and COD in water samples.
13. Enumeration of E. coli in water samples.
14. Assessment of suspended particulate matter (SPM).
15. Study of a simple ecosystem: Visit to pond, river, or hills.
16. Visit to areas affected by natural disasters.
17. Practical examination.

Suggested Reading

1. De. A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti. P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi.
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India (In Press).
5. Prasanthrajan M, Mahendran, P. P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition.
6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India.
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

CFT 1204 NSS-II 1(0+1)

Objectives

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

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies.

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

CFT 1205 NCC-II 1(0+1)

Objectives

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

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field 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.

Semester III

S. No.	Course Title	Credit Hours
1.	FSQ 2103 Food Chemistry II	3 (2+1)
2.	FPE 2105 Fluid Mechanics	3 (2+1)
3.	FPE 2106 Heat and Mass Transfer in Food Processing	3 (2+1)
4.	BES 2117 Basic Electronic Engineering	2 (1+1)
5.	FSQ 2104 Food Microbiology	3 (2+1)
6.	BES 2118 Engineering Mathematics- I	2 (2+0)
7.	BES 2119 Agricultural Informatics and Artificial Intelligence	3 (2+1)
8.	Skill Enhancement Course - V*	2 (0+2)
Total		**21 (13+8)**

FSQ 2103 Food Chemistry-II 3(2+1)

Objectives

1. Study chemical aspects of food and bio- materials and their importance in food processing.
2. Gain an understanding of chemicals responsible for flavour, pigments and colorants.
3. Have an idea of about the effect of processing on these biomolecules.
4. Gain the knowledge about role of enzymes in food processing.

Theory

Module I **(6 hours)**

Philosophy and definitions of flavour, Chemistry of food flavour; flavourmatics/ flavouring compounds, sensory assessment of flavour, technology for flavour retention.

Module II **(9 hours)**

Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs; Popular colors used in food and their fictional properties; Regulatory use of regulatory dyes; Colour losses during thermal processing.

Module III **(13 hours)**

Vitamin functions in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins, optimization and retention of vitamins. Important minerals and their function in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals. Various anti-nutritional factors their mode of action and inactivation.

Module IV **(6 hours)**

Enzymes in Food Processing: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid, enzyme specificity, Michaelis-Menten equation, regulation mechanism.

Practical

Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron; Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids), C, E; Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables.

Lecture Schedule

1. Philosophy and definitions of flavor.
2. Chemistry of food flavor.
3. Flavourmatics/ flavouring compounds.
4. Sensory assessment of flavor.
5. Technology for flavour retention.
6. Pigments in animal and plants kingdoms: Heme pigments, chlorophyll.
7. Pigments in animal and plants kingdoms: Carotenoids.
8. Pigments in animal and plants kingdoms: phenolic and flavonoids.
9. Pigments in animal and plants kingdoms: betalins.
10. Effect of processing on pigment behavior.
11. Technology for retention of natural colours of food stuffs.
12. Popular colors used in food and their fictional properties.
13. Regulatory use of regulatory dyes.
14. Colour losses during thermal processing.
15. Vitamin functions in body.
16. Vitamins: deficiency conditions.
17. Requirements, allowances of vitamins.
18. Enrichment, restorations, fortifications of vitamins.
19. Enrichment, restorations, fortifications of vitamins.
20. Losses of vitamins.
21. Optimization and retention of vitamins.
22. Important minerals and their function in body.
23. Minerals: deficiency conditions.
24. Requirements, allowances of minerals.
25. Enrichment, restorations, fortifications of minerals.
26. Losses of minerals.
27. Optimization and retention of minerals.
28. Various anti-nutritional factors their mode of action and inactivation.
29. Enzymes in Food Processing: Carbohydrases, proteasase, lipases.
30. Modification of food using enzymes.

31. Role of endogenous enzymes in food quality.
32. Enzymes use as processing aid.
33. Enzyme specificity, Michaelis-Menten equation.
34. Regulation mechanism of enzymes.

Practical Schedule

1. Preparation of mineral solution by using ash method.
2. Preparation of mineral solution by tri-acid method (dry and wet oxidations).
3. Estimation of calcium.
4. Determination of phosphorus.
5. Determination of iron.
6. Estimation of magnesium.
7. Estimation of tannins and phytic acid from food.
8. Determination of vitamin A (Total carotenoids).
9. Determination of vitamin C.
10. Determination of vitamin E.
11. Determination of ascorbic acid by dye method.
12. Determination of thiamin.
13. Determination of riboflavin.
14. Determination of food colors.
15. Assessment of hydrocolloids as food additives.
16. Assessment of various pectinases from fruits and vegetables.
17. Practical examination.

Suggested readings

1. Belitz, H.-D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-Verlag Berlin Heidelberg.
2. Fennema, O.R. 1996. Food Chemistry, 3rd edn. Marcel Dekker, Inc., New York, USA.

FPE 2105 Fluid Mechanics 3(2+1)

Objectives

1. Get idea about types of fluids and their properties.
2. Gain knowledge about the flow behaviour of the fluids.
3. Differentiate about various types of pumps and their use in food processing.

Theory

Module I **(11 Hours)**

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces, flow behavior of viscous fluids; Compressible and non-compressible fluids; Surface tension, capillarity; Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedes principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height.

Module II **(5 Hours)**

Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries.

Module III **(11 Hours)**

Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude.

Module IV **(7 Hours)**

Pumps: Classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps.

Practical

Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes; Study and operation of centrifugal and other pumps used in dairy and food processing plants.

Lecture Schedule

1. Units and dimensions.
2. Properties of fluids.
3. Properties of fluids-continued.
4. Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid.
5. Pressure on vertical rectangular surfaces.
6. Flow behavior of viscous fluids.
7. Compressible and non-compressible fluids, Surface tension, capillarity.

8. Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges and piezometer.
9. Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges and piezometer.
10. Floating bodies: Archimedis principle, stability of floating bodies.
11. Equilibrium of floating bodies, metacentric height.
12. Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent.
13. Continuity equation- Bernoulli's theorem.
14. Application of Bernoulli's theorem (Venturimeters, orifice meter, Pitot tube).
15. Navier-Stokes equations in cylindrical co-ordinates, boundary conditions.
16. Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries.
17. Flow through pipes: Loss of head.
18. Determination of pipe diameter, Determination of discharge, friction factor, critical velocity.
19. Flow through orifices, mouthpieces, notches and weirs.
20. Vena contracta, Hydraulic coefficients, discharge losses.
21. Time for emptying a tank.
22. Loss of head due to contraction, enlargement at entrance and exit of pipe.
23. External and internal mouthpieces.
24. Types of notches, rectangular and triangular notches, rectangular weirs.
25. Water level point gauge, hook gauge, rotameter.
26. Dimensional analysis: Buckingham's theorem application to fluid flow phenomena.
27. Froude Number, Reynolds number, Weber number and hydraulic similitude.
28. Pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump.
29. Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge.
30. Static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps.
31. Reciprocating pumps: Working of reciprocating pump, double acting pump.
32. Instantaneous rate of discharge, acceleration of piston and water, gear pump.
33. Pressure variation, work efficiency.
34. Pressure requirements for viscous foods to lift them to different heights and selection of pumps.

Practical Schedule

1. Study of different tools and fittings.
2. Study on flow rate versus pressure drop with U-tube manometer.
3. Verification of Bernoulli's theorem.
4. Determination of metacentric height and radius of gyration of floating bodies.
5. Determination of discharge co-efficient for venturimeter.
6. Determination of discharge co-efficient for orifice.
7. Determination of hydraulic coefficient for mouthpiece.

8. Determination of discharge co-efficient for V-notch.
9. Determination of discharge co-efficient for weir.
10. Verification of emptying time formula for a tank.
11. Flow through pipes- Major and minor losses.
12. Determination of critical Reynold's number by Reynold apparatus.
13. Study of reciprocating, centrifugal and gear pump.
14. Calibration of rotameter.
15. Study of different types of valves; Study of pumps for viscous fluid.
16. Study and operation of centrifugal and other pumps used in dairy and food processing plants.
17. Practical examination.

Suggested Reading

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N. 2002. Transport Phenomena, 2nd edn. John Wiley and Sons, Inc., New York, USA.
2. Çengel, Y. A. and Cimbala, J.M. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.
3. Finnemore, E.J. and Franzini, J.B. 2002. Fluid Mechanics with Engineering Applications, 10thedn. McGraw-Hill, Inc., New York, USA.
4. Munson, B.R., Young, D.R. and Okiishi, T.H. 2002. Fundamentals of Fluid Mechanics, 4thedn. John Wiley and Sons, Inc., New York, USA.
5. Nevers, N.D. 1991. Fluid Mechanics for Chemical Engineers. McGraw-Hill, Inc., New York, USA.
6. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Streeter, V.L. 1962. Fluid Mechanics, 3rdedn. McGraw-Hill Book Co., Inc., Boston, USA.
8. White, F.M. 2010. Fluid Mechanics, 7th edn. McGraw-Hill Book Co., Inc., Boston, USA.

FPE 2106 Heat and Mass Transfer in Food Processing 3(2+1)

Objectives

1. Have knowledge about the mechanism of heat and mass transfer
2. Get knowledge of dimensionless numbers involved in heat and mass transfer
3. Differentiate between different types of heat exchangers

Theory

Module I **(13 Hours)**

Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer, food properties measurements and errors; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions;

Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries.

Module II **(5 Hours)**

Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heisler charts and calculations; Heat transfer to flowing fluids.

Module III **(12 Hours)**

Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Efficiency and NTU analysis; Application of different types of heat exchangers in dairy and food industry.

Module IV **(4 Hours)**

Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Practical

Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products; Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer; mass transfer coefficient in foods; glass transition temperature of food sample; mass transfer during leaching process.

Lecture Schedule

1. Introduction to heat and mass transfer processes- different mode of heat transfer- conduction- convection- radiation.
2. Heat transfer coefficients- properties related to heat transfer.
3. Heat conduction- concept- conduction in solids-liquids-gases.
4. One dimensional steady state conduction with heat generation- theory of heat conduction.
5. Fourier's law and its derivation- thermal conductivity of material.
6. Concept of electrical analogy and its application for thermal circuits.
7. Heat transfer through composite walls and insulated pipelines.

8. Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation.
9. Heat conduction- development of equations of temperature distribution with different boundary conditions.
10. Steady state heat conduction with heat dissipation to environment.
11. Introduction to extended surfaces (fins) of uniform area of cross section- with equation of temperature distribution with different boundary conditions.
12. Effectiveness- efficiency of the fins.
13. Unsteady state heat conduction- introduction- system with negligible internal resistance and in various geometries.
14. Convection- concept- heat transfer coefficient- forced and free convection.
15. Use of dimensional analysis for correlating variables affecting convection heat transfer.
16. Concept of Nusselt number- Prandtl number- Reynolds number- Grashoff number- some important empirical relations used for determination of heat transfer coefficient.
17. Concept of Nusselt number- Prandtl number- Reynolds number- Grashoff number- some important empirical relations used for determination of heat transfer coefficient.
18. Heisler charts and calculations, Heat transfer to flowing fluids.
19. Radiation- introduction.
20. Basic theories and laws.
21. Heat radiation- electromagnetic spectrum- emissivity.
22. Absorptivity- transmissivity- reflectivity.
23. Radiation through black and grey surfaces.
24. Determination of shape factors.
25. Heat Exchangers- introduction- concept- general discussion- fouling factors.
26. Types of heat exchangers- jacketed kettles- LMTD- parallel and counter flow heat exchangers- shell and tube- plate heat exchangers.
27. Types of heat exchangers- jacketed kettles- LMTD- parallel and counter flow heat exchangers- shell and tube- plate heat exchangers.
28. Heat exchanger design- Efficiency and NTU analysis.
29. Heat exchanger design- Efficiency and NTU analysis.
30. Application of different types of heat exchangers in dairy and food industry.
31. Mass transfer- introduction- Fick's law of diffusion, Steady state diffusion of gases and liquids through solids.
32. Diffusion mass transfer-equimolal diffusion.
33. Isothermal evaporation of water into air-mass transfer coefficient.
34. Application of mass transfer in dairy and food industry.

Practical Schedule

1. Heat transfer analysis during conduction
2. Heat transfer analysis during convection.
3. Determination of thermal conductivity in a composite wall.
4. Study on various types of heat exchangers used in food industry.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of emissivity of the given test surface.

7. Determination of Stefan-Boltzmann constant in radiation heat transfer.
8. Determination of heat transfer coefficient in a parallel flow heat exchanger.
9. Determination of heat transfer coefficient in a counter flow heat exchanger.
10. Preparation and calibration of thermocouple.
11. Determination of thermal conductivity of different food products.
12. Study of working principle and constructional details of plate heat exchanger.
13. Study of working principle and constructional details of shell and tube heat exchanger.
14. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry.
15. Studies on temperature distribution and heat transfer in HTST pasteurizer.
16. Study of mass transfer during leaching process.
17. Practical Examination.

Suggested Reading

1. Cao, E. 2010. Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
2. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw- Hill Co., Inc., NY, USA.
3. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4thedn. Prentice-Hall, NY, USA.
4. Holman, J.P. 2010. Heat Transfer, 10thedn. McGraw-Hill Book Co., Boston, USA.
5. Lienhard IV, J.H. and Lienhard V, J.H. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
6. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7thedn. McGraw-Hill, Inc., NY, USA.
7. Ozişik, M.N. 1993. Heat Conduction, 2ndedn. John Wiley and Sons, NY, USA.
8. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
9. Rajput, R.K. 2008. Heat and Mass Transfer. S. Chand and Co., New Delhi
10. Richardson, J F., Harker, J.H. and Backhurst, J.R. 1999. Coulson and Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6th edn. Butterworth- Heinemann, Oxford, UK.
11. Treybal, R.E. 1980. Mass Transfer Operations, 3rdedn. McGraw-Hill Book Company, Auckland, USA.

BES 2117 Basic Electronics Engineering 2 (1+1)

Objectives

1. Study basic concepts of electronics and their relevance in food industry.
2. Get idea about various electronic components.

3 Knowledge about electronic device and their concept in measurement.

Theory

Module I **(5 Hours)**

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); voltage multiplier, filter circuits.

Module II **(4 Hours)**

Bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider).

Module III **(5 Hours)**

Ideal OP-AMP characteristics, linear and nonlinear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator, Zener diode voltage regulator, transistor series regulator, current limiters, OP-AMP voltage regulators; Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits binary ladder D/A converter and A/D converter

Module IV **(4 Hours)**

Transducers: Classification, selection criteria, characteristics, sensors and actuators construction, working principles, applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges, capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers, variable parameter type, digital, actuating and controlling devices.

Practical

Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as an active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

Lecture schedule

1. Semiconductors-Types-intrinsic semiconductors-extrinsic semiconductors-forward biased PN Junction- forward V-I Characteristics- reverse biased PN Junction-reverse V-I characteristics-combined forward and reverse V-I characteristics.
2. Diode as a circuit element-Half wave-center tapped full wave and full wave bridge rectifier
3. Voltage multiplier-Half wave and full wave voltage, doubler-voltage, tripler-voltage, quadruple.
4. Logic Gates-OR - AND gate- Diode OR and AND circuits.
5. Filters-LC filter-pi filter.
6. Bipolar junction transistor-NPN and PNP transistor.
7. Transistor biasing-CB, CE and CC configuration-static characteristics.

8. DC load line-Q point-operating point.
9. Different methods of transistor biasing- base bias-base bias with emitter feedback-base bias with collector feedback-voltage divider bias.
10. Op-Amps-virtual ground and summing point- ideal OP-AMP characteristics.
11. Linear amplifier-unity follower-adder- OP-Amp-subtractor-integrator- OP-AMP differentiator-comparator.
12. Zener diode- Zener voltage regulator-Transistor series voltage regulator.
13. Current limiters-OP-AMP voltage regulators.
14. Basic theorem of Boolean algebra- Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits -binary ladder D/A converter and A/D converter.
15. Transducers: Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices.
16. Working principles and applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges.
17. Working principles and applications of capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers.
18. Working principles and applications of variable parameter type, digital, actuating and controlling devices.

Practical schedule

1. To study V-I characteristics of p-n junction diode.
2. Study of RC coupled amplifier.
3. Study of RC phase shift oscillator.
4. Verification of logic gates.
5. Determination of energy gap in a junction diode.
6. Study of Zener diode.
7. To study Full Wave rectifier.
8. To study bridge rectifier.
9. To study transistor characteristics in CE configurations.
10. To study of OP-AMP IC 741 as inverting amplifier.
11. To study of OP-AMP IC 741 as non- inverting amplifier.
12. To study of OP-AMP IC 741 as differentiator.
13. To study of OP-AMP IC 741 as a active rectifier.
14. To study of OP-AMP IC 741 as a comparator.
15. Study of temperature characteristics of resistor.
16. To study a diode as clipper and clamper.
17. Practical Examination.

Suggested Readings

1. Anand Kumar. 2014. Fundamentals of Digital Circuits. PHI Pvt. Ltd., New Delhi.
2. Gupta, S. 2002. Electronic Devices and Circuits. Dhanpat Rai Publications (P) Limited, New Delhi.
3. Mehta, V.K. and Mehta, R. 2008. Principles of Electronics. S. Chand and Co., New Delhi.
4. Roy, D.C. 2003. Linear Integrated Circuits. John Wiley International, NY.

5. Sawhney, A.K. 2010. Course in Electrical and Electronics Measurements and Instrumentation. Dhanpat Rai Publications (P) Limited, New Delhi.

FSQ 2104 Food Microbiology 3(2+1)

Objectives

1. Microbiology of different foods
2. Food borne toxins
3. Understand spoilage of food

Theory

Module I **(10 Hours)**

Importance and significance of microbes in food science; Sources of microorganisms in foods and their effective control; Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc.

Module II **(10 Hours)**

Normal Microbiological quality of Foods and its significance: milk and milk products, fruits and vegetables, cereals and cereal products, meat and meat products, fish and other sea foods, poultry and eggs; sugar and sugar products, salts and spices and canned foods.

Module III **(7 Hours)**

Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Shelf life: Calculation of shelf life, Shelf-life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products.

Module IV **(7 Hours)**

Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins; Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.

Practical

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation; Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation; Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation;

Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

Lecture Schedule

1. Importance and significance of microbes in food science.
2. Sources of microorganisms in foods.
3. Effective control of microorganisms in foods.
4. Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc.
5. Factors affecting growth and survival of microorganisms in foods; Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc.
6. Normal Microbiological quality of Foods and its significance: milk and milk products.
7. Normal Microbiological quality of Foods and its significance: milk and milk products.
8. Normal Microbiological quality of Foods and its significance: fruits and vegetables.
9. Normal Microbiological quality of Foods and its significance: fruits and vegetables.
10. Normal Microbiological quality of Foods and its significance: cereals and cereal products.
11. Normal Microbiological quality of Foods and its significance: cereals and cereal products
12. Normal Microbiological quality of Foods and its significance: meat and meat products.
13. Normal Microbiological quality of Foods and its significance: meat and meat products.
14. Normal Microbiological quality of Foods and its significance: fish and other sea foods.
15. Normal Microbiological quality of Foods and its significance: fish and other sea foods.
16. Normal Microbiological quality of Foods and its significance: poultry and eggs.
17. Normal Microbiological quality of Foods and its significance: poultry and eggs.
18. Normal Microbiological quality of Foods and its significance: sugar and sugar products.
19. Normal Microbiological quality of Foods and its significance: sugar and sugar products.
20. Normal Microbiological quality of Foods and its significance: salts and spices.
21. Normal Microbiological quality of Foods and its significance: canned foods.
22. Normal Microbiological quality of Foods and its significance: canned foods.
23. Chemical changes caused by microorganisms: nitrogenous organic compounds.
24. Chemical changes caused by microorganisms: non-nitrogenous organic-organic acids-other compounds-lipids-pectic substances.
25. Shelf life: Calculation of shelf life.
26. Shelf-life requirements, deteriorative reactions, accelerated testing.
27. Simulations of product: Package environment interaction.
28. Shelf-life simulation for moisture, oxygen, and light sensitive products.
29. Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins.
30. Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins.
31. Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions.
32. Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions.

33. Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.
34. Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.

Practical Schedule

1. Isolation of bacteria and molds from foods.
2. Microbial examination of cereal and cereal products: Identification, isolation and confirmation.
3. Microbial examination of vegetable and fruits: Identification, isolation and confirmation.
4. Microbial examination of meat and meat products: Identification, isolation and confirmation.
5. Microbial examination of fish and other sea foods: Identification, isolation and confirmation.
6. Microbial examination of eggs and poultry: Identification, isolation and confirmation.
7. Microbial examination of milk and milk products: Identification, isolation and confirmation.
8. Microbial examination of sugar, salts and spices.
9. Microbial examination of canned products: Identification, isolation and confirmation.
10. Determination and enumeration of pathogenic and indicator organisms in foods (Coliform / Enterococcus).
11. Detection of coliforms from water by MPN method.
12. Determination thermal death time.
13. Detection of *Salmonella* from food sample.
14. Detection of *Salmonella* from food sample.
15. Detection of *Staphylococcus aureus* from food sample.
16. Detection of *Staphylococcus aureus* from food sample.
17. Practical examination.

Suggested Readings

1. Adams, M.R. and Moss, M.O. 2008. Food Microbiology, 3rd edn, The Royal Society of Chemistry, Cambridge, UK.
2. Banwart, G.J. 1989. Basic Food Microbiology, 2nd edn. Chapman and Hall, New York, USA.
3. Frazier, W.C. and Westfoff, D.C. 1987. Food Microbiology, 4th edn. Tata McGraw-Hill Education, New Delhi.
4. Jay, J.M. 2000. Modern Food Microbiology, 6th edn. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
5. Ray, B. and Bhunia, A. 2008. Fundamental Food Microbiology, 4th edn., CRC press, Taylor and Francis Group, USA.

BES 2118 Engineering Mathematics-I 2(2+0)

Objectives

1. Gain knowledge about curves and their expression in mathematical form.
2. Develop equations for a process and its integration.

Theory

Module I **(10 Hours)**

Taylor's and Maclaurin's expansions, indeterminate form, Curvature, asymptotes, tracing of curves function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima, and minima.

Module II **(8 Hours)**

Reduction formulae, Gamma, and Beta functions, Rectification of standard curves. Volumes and surfaces of revolution of curves, Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume.

Module III **(10 Hours)**

Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation; Differential equations of higher orders, methods of finding complementary functions and particular integrals, Method of variation of parameters simultaneous linear differential equations with constant coefficients, Cauchy's and Legendre's linear equations, Bessel's and Legendre's differential equations series solution techniques.

Module IV **(6 Hours)**

Differentiation of vectors, scalar and vector point functions, vector differential operator Del: Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, Identities involving Del, second order differential operator Line, Surface and volume integrals, Stoke's divergence and Green's theorems.

Lecture Schedule

1. Taylor's and Maclaurin's Expansions.
2. Indeterminate Forms and Curvature.
3. Asymptotes and Tracing of Curves.
4. Functions of Two or More Independent Variables.
5. Partial Differentiation and Homogeneous Functions.
6. Composite Functions and Total Derivatives.
7. Derivative of an Implicit Function and Change of Variables.
8. Jacobians and Error Evaluation.
9. Maxima and Minima of Multivariable Functions.
10. Maxima and Minima of Multivariable Functions.

11. Reduction Formulae.
12. Gamma and Beta Functions.
13. Rectification of Standard Curves.
14. Volumes and Surfaces of Revolution of Curves.
15. Double Integrals.
16. Triple Integrals.
17. Change of Order of Integration.
18. Application of Double and Triple Integrals to Find Area and Volume.
19. Exact and Bernoulli's Differential Equations.
20. Equations Reducible to Exact Form by Integrating Factors.
21. Equations of First Order and Higher Degree.
22. Clairaut's Equation.
23. Differential Equations of Higher Orders.
24. Methods of Finding Complementary Functions and Particular Integrals.
25. Method of Variation of Parameters.
26. Simultaneous Linear Differential Equations with Constant Coefficients.
27. Cauchy's and Legendre's Linear Equations.
28. Bessel's and Legendre's Differential Equations Series Solution Techniques.
29. Differentiation of Vectors, Scalar and Vector Point Functions.
30. Vector Differential Operator Del, Gradient of a Scalar Point Function.
31. Divergence and Curl of a Vector Point Function and Their Physical Interpretations.
32. Identities Involving Del, Second Order Differential Operator.
33. Line, Surface, and Volume Integrals.
34. Stoke's divergence and Green's Theorems.

Suggested Reading

1. Grewal, B. S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

BES 2119 Agricultural Informatics and Artificial Intelligence 3(2+1)

Objective

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

Theory

Module I **(10 hours)**

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, programming languages-machine language, assembly language, high level language- Visual Basic, Java, Fortran, C/ C++, etc. concepts (only introduction).

Module II **(10 hours)**

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.

Module III **(6 Hours)**

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.

Module IV **(8 hours)**

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 (only the concept introduction, a detailed study of algorithm not expected); 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.

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 scientific documents, MS- EXCEL - Creating a spreadsheet, use of statistical tools, Writing math 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, 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 Decision Support System, contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Lecture Schedule

1. Introduction to Computers, Anatomy of Computers.
2. Memory Concepts, Units of Memory.
3. Operating System: Definition and types.
4. Applications of MS-Office for creating, Editing, and Formatting a document.
5. Spreadsheet - Data presentation, Tabulation, and graph creation.
6. Spreadsheet- Statistical analysis, Mathematical expressions.
7. Database, concepts, and types, creating database, Uses of DBMS in Agriculture.
8. Internet and World Wide Web (www): Concepts and components.
9. Computer programming: General concepts–programming languages, structural programming.
10. Introduction to Visual Basic, Java, FORTRAN, C/C++ (only introduction, as examples).
11. e-Agriculture, concepts, design and development.
12. e-Agriculture, concepts, design and development.
13. Application of innovative ways to use information and communication technologies (IT) in Agriculture.
14. Computer Models in Agriculture: Statistical, weather analysis.
15. Crop simulation models, concepts, structure, inputs- outputs files, limitations, and advantages.
16. Application of models for understanding plant processes, sensitivity, verification, calibration, and validation.
17. IT applications for computation of water and nutrient requirements of crops.
18. IT applications for computation of water and nutrient requirements of crops.
19. Computer-controlled devices (automated systems) for Agri-input management.
20. Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management.
21. Geospatial technology: concepts, techniques, components.
22. Geospatial technology: uses for generating valuable agri-information.
23. Decision support systems: Concepts components and applications in agriculture.
24. Agriculture Expert System; Soil Information Systems etc. for supporting farm decisions.
25. Preparation of contingent crop-planning and crop calendars using IT tools.
26. Digital India and schemes to promote digitalization of agriculture in India.
27. Introduction to artificial intelligence, background, and applications, Turing test.
28. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm (only concepts expected).

29. IoT and Big Data in agriculture.
30. Use of AI in agriculture for autonomous crop management-intelligent pesticide application.
31. AI in crop health monitoring, and monitoring livestock health.
32. AI in yield mapping and predictive analysis.
33. Automatic weeding and harvesting-sorting of produce-other food processing applications.
34. Concepts of smart agriculture and the use of AI in food and nutrition science.

Practical Schedule

1. Study of computer components, accessories, practice of important DoS Commands.
2. Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, and File Management.
3. Use of MS-WORD for creating, editing and formatting documents.
4. MS PowerPoint for creating, editing, and presenting scientific documents.
5. MS- EXCEL - Creating a spreadsheet, writing expressions, Creating graphs.
6. Analysis of scientific data, Use of statistical tools, Handling macros in Spreadsheet.
7. MS-ACCESS: Creating Database, preparing queries and reports.
8. Demonstration of Agri- information system.
9. Introduction to World Wide Web (WWW) and its components.
10. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/Wofost (any one model).
11. Preparation of inputs file for CSM and study of model outputs.
12. Computation of water and nutrient requirements of crop using CSM and IT tools.
13. Demonstration of mobile phone applications for agriculture.
14. Introduction of Geospatial Technology for agriculture.
15. Hands-on practice of Decision Support System/crop planning.
16. India Digital Ecosystem of Agriculture (IDEA), AI application in food Industry (Internet sources).
17. Practical examination.

Suggested Readings

1. Choudhary K. R. Fundamentals of Artificial Intelligence. Springer
2. Date, C. J. 2000. Introduction to Database Management System. Addison-Wesley.
3. ITL Educations Solutions Ltd. Introduction to Information Technology. Pearson Education.
4. Kumar, E. 2020. Artificial Intelligence. Wiley.
5. Introductory Agri Informatics by Mahapatra, Subrat Ketal, Jain Brothers Publication.
6. Nilson, N.J. 2001. Principles of Artificial Intelligence. Narosa.
7. Rajaraman, V. and Adabala, N. Fundamentals of Computers. PHI Learning Pvt. Ltd, New Delhi.
8. Vanitha, G. 2023. Agro-Informatics. NIPA, New Delhi.
9. Sethi, D.P. and Pradhan, M. 2017. Concepts and Techniques of Programming in C.I.K. International Publishing House, Pvt. Ltd.

Semester IV

S. No.	Course Title	Credit Hours
1.	FPE 2207 Fundamentals of Food Engineering	3 (2+1)
2.	FSQ 2205 Food Plant Sanitation	3 (2+1)
3.	FSQ 2206 Food Quality, Safety Standards and Certification	2 (2+0)
4.	BES 2221 Engineering Mathematics- II	2 (2+0)
5.	FPO 2201 Food Plant Utilities and Services	3 (2+1)
6.	BES 2222 Entrepreneurship Development and Business Management	3 (2+1)
7.	BES 2223 Personality Development	2 (1+1)
8.	BES 2220 Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)
9.	Skill Enhancement Course - VI*	2 (0+2)
Total		**22 (13+9)**

FPE 2207 Fundamentals of Food Engineering 3(2+1)

Objectives

1. To gain an understanding on the basic concepts of engineering principles applied to food.
2. To familiarize students to the fundamental unit operations in the postharvest processing of agricultural commodities.

Theory

Module I **(8 Hours)**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; Classification and selection of dryers: tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; Dryers for liquid: drum or roller dryer, spray dryer and foam-mat dryers.

Module II **(8 Hours)**

Size reduction: Benefits, classification, determination of the fineness of ground material, sieve/screen analysis; Principle and mechanisms of comminution of food: Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Major types-crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, burr mill, tumbling mills, ultra-fine grinders, fluid jet pulverizer, colloid mill; Cutting machines (slicing, dicing, shredding, pulping).

Module III **(11 Hours)**

Mixing: Theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment:

Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids; Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine; Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids.

Module IV **(7 Hours)**

Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

Practical

Determination of fineness modulus and uniformity index, Determination of mixing index of a feed mixer, Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law, Performance evaluation of hammer mill, Performance evaluation of attrition mill, Study of centrifugal separator, Study of freeze dryer and freeze-drying process, Study on osmosis in fruits, Determination of solid gain and moisture loss during osmosis, Study of reverse osmosis process, Study of ultrafiltration/membrane separation process.

Lecture schedule

1. Introduction to Food Engineering.
2. Drying and dehydration-basic drying theory, heat and mass transfer in drying.
3. Drying rate curves-calculation of drying times-dryer efficiencies.
4. Classification and selection of dryers-tray dryer, vacuum dryer, osmotic dryer.
5. Fluidized bed dryer-pneumatic dryer-rotary dryer-tunnel.
6. Trough dryer-bin dryer-belt dryer-microwave dryer-IR dryer.
7. Heat pump dryer-freeze dryer.
8. Dryers for liquid: drum dryer-roller dryer-spray dryer-foam-mat dryer.
9. Size reduction-benefits-classification.
10. Determination of the fineness of ground material- Sieve/screen analysis.
11. Principle and mechanisms of comminution of food.
12. Size reduction laws-Rittinger's law, Kick's law and Bond's law-work index-energy utilization.
13. Size reduction equipment-Crushers-jaw crushers, gyratory, smooth roll.
14. Hammer mills and impactors-attrition mills-burr mill.
15. Tumbling mills-ultrafine grinders-fluid jet pulverizer-colloid mill.
16. Cutting machines-slicing, dicing, shredding and pulping.
17. Mixing-Theory of solids mixing.
18. Criteria of mixer effectiveness-mixing indices-rate of mixing.

19. Theory of liquid mixing-power requirement for liquids mixing.
20. Mixing equipment-mixers for low- or medium-viscosity liquids- paddle agitators, impeller agitators, powder-liquid contacting devices.
21. Mixers for high viscosity liquids and pastes- Mixers for dry powders and particulate solids.
22. Mechanical separations-Theory-centrifugation-liquid-liquid centrifugation-liquid-solid centrifugation.
23. Clarifiers-desludging and decanting machine.
24. Filtration-theory of filtration, rate of filtration, pressure drop during filtration.
25. Filtration-applications, constant-rate filtration and constant-pressure filtration, derivation of equation.
26. Filtration equipment-plate and frame filter press, rotary filters.
27. Filtration equipment-centrifugal filters-air filters-filter aids.
28. Membrane separation-general considerations-materials for membrane construction.
29. Ultra-filtration-microfiltration-concentration-polarization-processing variables.
30. Membrane fouling-applications of ultra-filtration in food processing.
31. Reverse osmosis-mode of operation-applications.
32. Membrane separation methods-demineralization by electro-dialysis.
33. Gel filtration-ion exchange and per-evaporation.
34. Osmotic dehydration-principle and applications.

Practical Schedule

1. Determination of fineness modulus and uniformity index.
2. Determination of mixing index of a feed mixer.
3. Study of various solid food dryers.
4. Study of various liquid food dryers.
5. Numerical problems on drying process.
6. Power requirement in size reduction: Rittinger's law, Kick's law and Bond's law.
7. Performance evaluation of hammer mill.
8. Performance evaluation of attrition mill.
9. Study on different types of crushers.
10. Study of centrifugal separator.
11. Study of freeze dryer and freeze-drying process.
12. Study on osmosis in fruits.
13. Determination of solid gain and moisture loss during osmosis.
14. Study of reverse osmosis process.
15. Study of ultrafiltration/membrane separation process.
16. Industrial visit.
17. Practical Examination.

Suggested Readings

1. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
2. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
3. McCabe, W.L., Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.

4. Mohsenin, N. N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, New York.
5. Mohsenin, N. N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
6. Mohsenin, N. N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
7. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
8. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth-Heinemann, Oxford, UK.
9. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.

FSQ 2205 Food Plant Sanitation 3 (2+1)

Objectives

1. Importance of sanitation and hygiene and its application to food
2. Gain knowledge of Hazard Analysis and Critical Control Point
3. Learn good manufacturing practices

Theory

Module I **(10 Hours)**

Sanitation and food industry: Sanitation, sanitation laws, regulations, and guidelines, establishment of sanitary Practices. Foodborne bioterrorism: Potential risks and protection measures for bioterrorism. The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures. The Relationship of allergens to sanitation: Food allergens and its control measures. Food contamination sources: Sources of contamination, contamination of foods, protection against contamination.

Module II **(8 Hours)**

Personal hygiene and sanitary food handling: Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility. Cleaning compounds and sanitizers: Classification, selection of cleaning compounds and sanitizers, CIP and COP, handling and storage, precautions.

Module III **(8 Hours)**

Pest and Rodent Control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management. Sanitary design and construction for food processing: Site selection, site preparation, building construction considerations, processing and design considerations, pest control design.

Module IV **(8 Hours)**

Waste product handling: solid waste and liquid waste management. Role of HACCP in sanitation: Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices.

Practical

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices (GMPS) and personal hygiene; Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test; Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.

Lecture schedule

1. Sanitation and food industry: sanitation, sanitation laws.
2. Regulations, and guidelines, establishment of sanitary practices.
3. Foodborne bioterrorism: potential risks and protection measures for bioterrorism.
4. The relationship of microorganisms to sanitation.
5. Microbial growth in relation to spoilage and food borne out breaks and its control measures.
6. Microbial growth in relation to spoilage and food borne out breaks and its control measures.
7. The relationship of allergens to sanitation.
8. Food allergens and its control measures.
9. Sources of contamination and contamination of foods.
10. Protection against contamination.
11. Personal hygiene.
12. Employee hygiene.
13. Sanitary food handling.
14. Role of employee supervision.
15. Employee responsibility.
16. Cleaning compounds and sanitizers: classification, selection of cleaning compounds and sanitizers.
17. CIP and COP.
18. Cleaning compounds and sanitizers: handling and storage, precautions.
19. Pest and rodent control: introduction.
20. Insect infestation.
21. Cockroaches, insect destruction, rodents, birds.
22. Use of pesticides.
23. Integrated pest management.
24. Sanitary design and construction for food processing: introduction.

25. Site selection, site preparation, building construction considerations, processing and design considerations.
26. Pest control design.
27. Waste product handling: introduction.
28. Solid waste management.
29. Liquid waste management.
30. Role of HACCP in sanitation.
31. HACCP principles.
32. Good manufacturing practices, current good manufacturing practices.
33. Standard operating procedures.
34. Good laboratory practices.

Practical Schedule

1. Estimation of BOD (Biological Oxygen Demand).
2. Estimation of COD (Chemical Oxygen Demand).
3. Determination of hardness of water.
4. Good Manufacturing Practices (GMPS) and personal hygiene.
5. Sewage treatment: Primary, secondary, tertiary and quaternary.
6. Aerobic and anaerobic sludge treatment.
7. Lab demonstration on state of water.
8. Study of CIP plant.
9. Isolation and identification of Actinomycetes.
10. Enrichment and isolation of cellulose degrading bacteria.
11. Biodegradation of phenol compounds.
12. Bacteriological examination of water: Coliform MPN test.
13. Sampling of airborne microorganisms.
14. Sampling of surfaces - equipment and physical plant.
15. Aerosol sampling and measurement guidelines.
16. Visit to food processing industries for HACCP verification
17. Practical Examination.

Suggested Reading

1. Cramer, M.M. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.
2. Hui, Y.H., Bruinsma, B.L., Gorham, J.R., Nip, W.-K., Tong, P.S., and Ventresca, P. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.
3. Mitchell, R. and Gu, J. D. 2010. Environmental Microbiology, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
4. Marriott, N.G. and Gravani, R.B. 2006. Principles of Food Sanitation, 5th edn. Springer Science and Business Media, Inc., NY, USA.
5. Pepper, I.L. and Gerba, C.P. 2005. Environmental Microbiology: Laboratory Manual, 2nd edn. Elsevier Academic Press, Amsterdam.

FSQ 2206 Food Quality, Safety Standards and Certification 2(2+0)

Objectives

1. To familiarize the students with quality and safety of food and the standards and certification available.
2. Understand quality and its assessment.
3. Learn different food laws and FSMS 22000.

Theory

Module I **(7 Hours)**

Introduction: Definition, its role in food industry, Quality attributes; Quality Defects: Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects. Measurement of defects by different techniques.

Module II **(12 hours)**

Quality assessment; quality assessment of food materials on the basis of sensory evaluation, physical, chemical microbiological methods; quality of products during processing and after processing; factors influencing the food qualities: soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Role of QC and QA quality: quality control, quality assurance, concepts of quality control and quality assurance functions in food industries; quality improvement total quality management: quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality.

Module III **(5 Hours)**

Food Laws; Food Laws and Standards: National and International food laws. Mandatory and voluntary food laws. Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities. AGMARK, BIS, FPO, Weights and Measures Act, CODEX; Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO –standards and certification process.

Module IV **(10 Hours)**

Weights and Measures Act and Packaged commodity rules; Role of CODEX in food safety and standards, Food safety issues and risk analysis; FSMS 22000, Food Safety Management Systems, ISO 22000 – 2005 and other Global Food safety management systems. Principles, implementation; documentation, types of records; Auditing, certification procedures, certifying bodies, accrediting bodies.

Lecture schedule

1. Food quality- definition and its role in food industry.
2. Food quality-quality attributes classification.

3. Quality defects and classification- genetic-physiological defects, pathological defects.
4. Entomological defects: holes, scars, lesions, off coloring, curled aves.
5. Various defects and classification- mechanical defects.
6. Various defects and classification- extraneous or foreign material defects.
7. Measurement of defects – different techniques.
8. Quality assessment of food materials on the basis of sensory evaluation.
9. Sensory evaluation methods, panel selection methods.
10. Interpretation of sensory results.
11. Quality of raw materials-physical, chemical and microbial quality.
12. Quality of products during processing and after processing: color, taste, texture, flavour, appearance.
13. Quality of products during processing and after processing: color, taste, texture, flavour, appearance.
14. Factors influencing the food qualities-soil, field practices, harvesting practices, procedures, packaging, transportation, storage conditions, processing conditions.
15. Factors influencing the food qualities- packaging and storage conditions of finished products.
16. Quality control (QC) and quality assurance (QA) in food industry – role, concepts and functions.
17. Food safety management systems- total quality management (TQM).
18. TQM - quality evolution, principles, stages in implementation and TQM road map.
19. Quality improvement tools, customer focus, cost of quality.
20. Food laws and standards: national and international food laws.
21. Food laws and standards: mandatory and voluntary food laws.
22. Food regulations and certification in India- food safety and standards act, FSSAI.
23. Food adulteration, misbranding, common adulterants in foods.
24. Food safety authorities - duties and responsibilities.
25. Weights and measures act and packaged commodity rules.
26. AGMARK, BIS and FPO – standards and certification process.
27. Role of codex in food safety and standards.
28. Food safety issues and risk analysis; FSMS 22000.
29. Food safety management systems, ISO 22000–2005 and other global food safety management systems.
30. Hazards and HACCP (Hazard analysis and critical control point)-principles.
31. Preparation of HACCP plan, development of HACCP plan for food industries.
32. Preparation of HACCP plan, development of HACCP plan for food industries.
33. Documentation and types of records, auditing.
34. Certification-procedure, certifying and accrediting bodies.

Suggested Reading

1. Alli, I. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.
2. Hester, R.E. and Harrison, R.M. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK.

3. Schmidt, R.H. and Rodrick, G.E. 2003. Food Safety Handbook. John Wiley and Sons, Inc., Hoboken. New Jersey, USA.

BES 2221 Engineering Mathematics-II 2(2+0)

Objectives

1. To familiarize the students with the basic concept of mathematics.
2. Gain knowledge about matrix and their transformation.
3. Develop partial differential equations and their applications.

Theory

Module I **(12 Hours)**

Elementary transformation and rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix; Consistency and solution of linear equations; Eigen value and eigen vectors, Cayley-Hamilton theorem; Linear and orthogonal transformations; Diagonalization of matrices, Bilinear, Quadratic forms.

Module II **(5 Hours)**

Limit, continuity, derivative of function of complex variable; Analytical function, C-R equations, conjugate function, harmonic functions.

Module III **(8 Hours)**

Infinite series and its convergence, periodic function, Euler's formulae for calculating Fourier coefficients, Dirichlet's conditions; Fourier series of functions with arbitrary period; Fourier series of odd and even functions; Half range sine and cosine series, Harmonic analysis.

Module IV **(9 Hours)**

Formation of partial differential equations; Lagrange's linear equation; Higher order linear partial differential equation with constant coefficients; Solution of non-linear partial differential equation (Charpit's method); Application of partial differential equations: One dimensional wave e.g., one-dimensional heat equation, two-dimensional steady state heat equation i.e. Laplace equation.

Lecture Schedule

1. Elementary transformation and rank of a matrix.
2. Reduction to normal form.
3. Gauss-Jordan method to find inverse of a matrix.
4. Consistency and solution of linear equations.
5. Consistency and solution of linear equations.
6. Eigen value and eigen vectors.
7. Eigen value and eigen vectors.
8. Cayley-Hamilton theorem.
9. Linear and orthogonal transformations.
10. Diagonalization of matrices.

11. Bilinear, Quadratic forms.
12. Bilinear, Quadratic forms.
13. Limit, continuity, derivative of function of complex variable.
14. Analytical function, C-R equations.
15. C-R equations.
16. Conjugate function.
17. Harmonic functions.
18. Infinite series and its convergence.
19. Periodic function, Euler's formulae for calculating Fourier coefficients.
20. Fourier series, Dirichlet's conditions.
21. Fourier series of functions with arbitrary period.
22. Fourier series of odd and even functions.
23. Half-range sine and cosine series.
24. Harmonic analysis.
25. Harmonic analysis
26. Introduction to partial differential equations (PDE), Formation of PDE.
27. Lagrange's linear equation.
28. Higher order linear partial differential equation with constant coefficients.
29. Higher order linear partial differential equation with constant coefficients.
30. Solution of non-linear partial differential equation (Charpit's method).
31. Solution of non-linear partial differential equation (Charpit's method).
32. One dimensional wave equation (problems only).
33. One dimensional wave equation (problems only).
34. Solution of two-dimensional steady state heat equation i.e., Laplace equation (problems only).

Suggested Reading

1. Grewal, B. S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

FPO 2201 Food Plant Utilities and Services 3 (2+1)

Objectives

1. Gain knowledge of various utilities and services required in a food processing plant.
2. Understanding working of different services.
3. Understand cleaning, maintenance and trouble shooting.

Theory

Module I **(8 Hours)**

Classification of various utilities and services in food Plant/ industry. Commercial energy Pricing; Electrical System-Introduction to electric power supply systems, electrical billing,

electrical load management and maximum demand control, power factor improvement and benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system. Electrical motors- types, losses in Introduction motor, motor efficiency, factors affecting motor performers, performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module II **(10 Hours)**

Compressed air system- Requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and efficiency. HVAC and Refrigeration system- Requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and saving opportunities. Vapor absorption refrigeration system: Working principle, types and comparison with VCR system, saving potential; Fans and blowers- Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, Pumps and pumping systems-Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Module III **(10 Hours)**

DG set system- Requirement, introduction, factors affecting selection; Fuels and combustion- Introduction to fuels; properties of fuel oil, coal and gas; storage; handling and preparation of fuels; principles of combustion, combustion of oil, coal and gas; draft system. Boilers- Boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities; Steam system- Properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings.

Module IV **(6 Hours)**

Waste heat recovery- Classification, advantages and application, commercially viable waste heat recovery devices, saving potential; other utilities and services- Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system.

Practical

Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities.; electrical power supply system, billing and load estimation; Motors and variable speed drives specification, selection, performance terms and definitions; compressed air system components and performance terms and definitions; refrigeration and HVAC system components, performance terms and definitions and load estimation of a plant; fans and blowers, types, specification, performance terms and definitions. Pumps types, specification, selection, performance terms and definitions; plant lighting system and their components; DG system their specification and selection; combustion of oil, gas and coal; boiler performance terms and assessment. Study on cost of steam; waste heat recovery devices. Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger (Shell and tube, PHE, run around coil exchanger, direct contact HX), Waste heat recovery boilers, Heat pumps and

Thermo compressor. ClP system components; water treatment plant; effluent treatment plant; fire control operations and use of fire extinguishers.

Lecture Schedule

1. Classification of various utilities and services in food plant/ industry.
2. Commercial energy pricing.
3. Electrical system- introduction to electric power supply systems.
4. Electrical billing, electrical load management and maximum demand control.
5. Power factor improvement and benefits.
6. Transformers, system distribution losses, harmonics, trouble shooting of electrical power system.
7. Electrical motors- types, losses in introduction motor, motor efficiency, factors affecting motor performers, performance.
8. Rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.
9. Compressed air system- requirement, types.
10. Compressor efficiency, efficient compressor operation, compressed air system components.
11. Capacity assessment, leakage test, factors affecting the performance and efficiency of compressed air system.
12. HVAC and refrigeration system- requirement.
13. Vapor compression refrigeration cycle.
14. Refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and saving opportunities.
15. Vapor absorption refrigeration system: working principle, types and comparison with VCR system, saving potential.
16. Fans and blowers- requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.
17. Pumps and pumping systems- requirement, types, performance evaluation.
18. Efficient system operation, flow control strategies and energy conservation opportunities.
19. DG set system- requirement, introduction, factors affecting selection.
20. Fuels and combustion- introduction to fuels.
21. Properties of fuel oil, coal and gas- storage- handling and preparation of fuels.
22. Principles of combustion, combustion of oil, coal and gas- draft system.
23. Boilers- boiler specification, Indian boiler regulation.
24. System components- types, combustion in boilers, performance terms.
25. Analysis of losses, feed water treatment, blow down, energy conservation opportunities.
26. Steam system- properties of steam, assessment of steam distribution losses.
27. Steam system- steam leakage, steam trapping,
28. Condensate and flash steam recovery system, opportunities for energy savings.
29. Waste heat recovery- classification, advantages and application.
30. Commercially viable waste heat recovery devices, saving potential.
31. Other utilities and services- lighting.
32. CIP system.

33. Waste water/drainage, water treatment.
34. Dust removal, fire protection and maintenance system.

Practical Schedule

1. Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities.
2. Electrical power supply system, billing and load estimation.
3. Motors and variable speed drives specification, selection, performance terms and definitions.
4. Compressed air system components and performance terms and definitions.
5. Refrigeration and HVAC system components, performance terms and definitions and load estimation of a plant.
6. Fans and blowers, types, specification, performance terms and definitions.
7. Pump types, specification, selection, performance terms and definitions- plant lighting system and their components.
8. DG system their specification and selection.
9. Combustion of oil, gas and coal, boiler performance terms and assessment.
10. Study on cost of steam.
11. Waste heat recovery devices.
12. Study of recuperates, regenerators, heat wheel, heat pipes, economizers, heat exchanger (shell and tube, PHE, run around coil exchanger, direct contact HX), waste heat recovery boilers, heat pumps and thermo compressor.
13. ClP system components.
14. Study of water treatment plant.
15. Study of effluent treatment plant.
16. Fire control operations and use of fire extinguishers.
17. Practical Examination.

Suggested Reading

1. Energy Efficiency and Management in Food Processing Facilities by Lijun Wang. Published by CRC Press, 2008.
2. Energy-saving Techniques for the Food Industry by M. E. Casper. Published by Noyes Data Corp., 1977.
3. Chilton's Food Engineering. Published by Chilton Co., 1979.
4. A Survey of Water Use in the Food Industry by W. E. Whitman, S. D. Holdsworth. Published by British Food Manufacturing Industries Research Association.

BES 2222 Entrepreneurship Development and Business Management 3(2+1)

Objectives

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

Theory

Module I **(7 Hours)**

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.

Module II **(7 Hours)**

Environment scanning and opportunity identification, need for scanning – spotting of opportunities – scanning of the environment – identification of product/service – starting a project. Factors influencing the sensing of opportunities. Infrastructure and support systems – good policies, schemes for entrepreneurship development, role of financial institutions, and other agencies in entrepreneurship development.

Module III **(8 Hours)**

Steps involved in the 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 the project. Project report preparation and enterprise management.

Module IV **(6 Hours)**

Production management – product, levels of products, product mix, quality control, cost of production, production controls. Material management – raw material costing, inventory control. Personal management – manpower planning, labor turnover, wages/salaries.

Module V **(6 Hours)**

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

Practical

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

Lecture Schedule

1. Concept and Definition of Entrepreneurship.
2. Evolution and Growth of Entrepreneurship.
3. Importance and Role of Entrepreneurs in Economic Development.
4. Motivational Factors for Entrepreneurship.

5. Characteristics and Traits of Successful Entrepreneurs.
6. Entrepreneurial Competencies and Attributes.
7. Social and Environmental Factors Affecting Entrepreneurship.
8. Need for and Importance of Entrepreneurial Development.
9. Objectives of Entrepreneurial Activities.
10. Types of Entrepreneurs (e.g., Innovators, Imitators, etc.).
11. Functions of Entrepreneurs.
12. Steps in Entrepreneurship Development.
13. Environment Scanning for Opportunity Identification.
14. Spotting Opportunities and Scanning the Environment.
15. Identification of Product/Service for New Ventures.
16. Infrastructure for Entrepreneurship Development.
17. Role of Financial Institutions in Supporting Entrepreneurs.
18. Government Policies and Schemes for Entrepreneurship Development.
19. Role of Other Agencies (Incubators, Accelerators, NGOs).
20. Steps in Enterprise Functioning.
21. Selection of Product/Service and Form of Ownership.
22. Registration, Licensing, and Legal Formalities.
23. Site Selection and Capital Sourcing.
24. Acquisition of Manufacturing Know-How, Packaging, and Distribution.
25. Project Identification and Selection, Project Formulation and Report Preparation.
26. Enterprise Management and Project Execution.
27. Production Management: Product and Quality Control.
28. Material Management: Raw Material Costing and Inventory Control.
29. Financial Management: Fund Sources, Fixed and Working Capital.
30. Accounting Principles: Book Keeping, Journals, Ledgers, Annual Statements.
31. Marketing Management: Market Types, Strategies, Assistance.
32. Crisis Management: Raw Material, Production Issues.
33. Leadership and Financial Crises.
34. Market Crises and Natural Disasters: Managing Entrepreneurial Risk.

Practical Schedule

1. Visit to Small Scale Industries.
2. Motivational Factors for Entrepreneurship-Analyze the various motivational factors that drive individuals to become entrepreneurs. Provide real-life examples to support your analysis.
3. Interaction with Successful Entrepreneurs.
4. Visit to Agro-Industries.
5. Characteristics of Successful Entrepreneurs- Identify five successful entrepreneurs and evaluate their key characteristics. Compare these traits and explain how they contribute to their success.
6. Interaction with Agri-entrepreneurs.

7. Environmental Scanning and Opportunity Identification-Conduct an environmental scan for a specific industry (e.g., retail, technology, or agriculture). Identify three potential business opportunities and explain the factors that influenced your choices.
8. Visit to Financial Institutions.
9. Infrastructure and Support Systems for Entrepreneurship Development- Research and evaluate the infrastructure and support systems available for entrepreneurs in your country. Discuss the role of government policies, financial institutions, and other support agencies.
10. Visit a local entrepreneurship development agency or incubator.
11. Steps in setting up a Business- Create a detailed step-by-step guide on how to start a business, covering product selection, form of ownership, registration, site selection, and sourcing capital.
12. Project Proposal Preparation- Choose a business idea and prepare a project proposal that includes product identification, market analysis, financial planning, and a marketing strategy. The proposal should be suitable for submission to a financial institution or investor.
13. Production Management and Quality Control- Analyze the production process for a specific product. Discuss how quality control is managed and suggest improvements for efficiency and cost reduction.
14. Financial Management in Entrepreneurship- Prepare a financial plan for a small business. Include fixed capital, working capital, costing, pricing, and short-term and long-term financial planning. Incorporate concepts like bookkeeping, journal entries, and taxation.
15. Crisis Management Strategies - Develop a crisis management plan for a hypothetical business facing a shortage of raw materials, production delays, or market disruptions. Include strategies for leadership, finance, and market crisis management.
16. Market Research for Project Proposal- Conduct market research to analyze customer demand, competitors, and market gaps.
17. Practical examination.

Suggested Reading

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

BES 2223 Personality Development 2(1+1)

Objectives

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

Theory

Module I **(5 Hours)**

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 Behaviour, personality and Organizational Behaviour.

Module II **(7 Hours)**

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.

Module III **(6 Hours)**

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.

Lecture Schedule

1. Personality-definition, Nature of personality, theories of personality and its types.
2. The humanistic approach - Maslow's self-actualization theory, shaping of personality.
3. Determinants of personality, Myers-Briggs Typology Indicator.
4. Locus of control and performance.
5. Type A and Type B Behaviours, Personality and Organizational Behaviour.
6. Foundations of individual behavior and factors influencing individual behavior.
7. Models of individual behavior.
8. Perception and attributes and factors affecting perception.
9. Attribution theory and case studies on Perception and Attribution.
10. Learning: Meaning and definition, theories and principles of learning.
11. Learning and organizational behavior.
12. Learning and training, learning feedback.
13. Attitude and values, Intelligence- types of Intelligence

14. Theories of intelligence, measurements of intelligence, factors influencing intelligence.
15. Intelligence and Organizational behavior, emotional intelligence.
16. Motivation-theories and principles.
17. Team work and group dynamics.

Practical Schedule

1. MBTI personality analysis.
2. MBTI personality analysis.
3. Learning Styles and Strategies.
4. Motivational needs, excercises.
5. Motivational classes from eminent speakers.
6. Firo-B Model -puzzles, games.
7. Firo-B tools and tests, questionnaire.
8. Interpersonal Communication.
9. Interpersonal Communication – excercises.
10. Teamwork and team building.
11. Teamwork and team building activities.
12. Group Dynamics – activities.
13. Win-win game.
14. Conflict Management.
15. Leadership styles.
16. Case studies on Personality and Organizational Behavior.
17. Practical examination.

Suggested Reading

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

BES 2220 Physical Education, First Aid, Yoga Practices and Meditation 2(0+2)

Objectives

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

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic anaerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to aging and role of regular exercise on aging process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture; Yoga: History of Yoga, Types of Yoga, Introduction to Yoga. Suryanamaskar Pranayama (Definition and Importance), Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari. Role of yoga in sports. Teaching of Asanas- demonstration, practice, correction and practice. Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan-left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan. Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table tennis, badminton, volleyball, basketball, kabaddi and Kho-Kho) and Athletics. Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with wounds and injuries. First aid related with Bones, Joints, Muscle related injuries. First aid related with Nervous system and unconsciousness. First aid related with gastrointestinal tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Practical Schedule

1. Health Related Physical Fitness Test-One-mile run, abdominal sit ups – 1 minute, sit and reach, modified pull ups.
2. Flexibility components – Speed, Strength, Endurance, Power, Agility, Coordination and Balance.
3. Training exercises - Fartlek training, Circuit training.
4. First AID Techniques.
5. Yoga – Practices.
6. Suryanamskar, Pranayama, Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
7. Teaching of Asanas–demonstration, practice, correction and practice.
8. Asanas - Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan,

Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan–leftleg-rightleg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan.

9. Meditation- Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh.
10. Mudras - Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
11. Coaching and fundamentals of skill developments of major games (any two).
12. Basketball – Dribbling and Holding.
13. Basketball - Passing – chest pass, bounce pass, overhead pass.
14. Basketball – Shooting – lay ups, free throw, jump shot.
15. Basketball – Moves – two-man, three-man weave, four-man and five-man running.
16. Basketball – Tactics – offences, defence, pivot and screening.
17. Volleyball – Stance and Service – under hand, tennis service, jump service.
18. Volleyball – Passing – upper hand and under hand.
19. Volleyball – Lift – vertical, arch, short.
20. Volleyball – Smash and Block.
21. Football – Passing and Stopping – instep, inside, back pass, wall pass weaving, long pass.
22. Football – Dribbling and Juggling, Trapping – foot trapping, chest, thigh and head.
23. Badminton – Grip – forehand and backhand, Service, Lob – underhand and overhand, overhead strokes, Drop shot and Smash, Tactics – Singles and Doubles.
24. Cricket – Stance – front foot drive, back foot defence, pull shot.
25. Cricket – Bowling – spin and fast bowling.
26. Table Tennis – Grip - forehand and backhand, Service, Tactics – Singles and Doubles.
27. Kabaddi – Tactics - Riding, Defence, Chain holding.
28. KhoKho – Tactics - Riding and Defence.
29. Coaching and Tactic development of athletic events – Conditioning (warming up – jogging - freehand exercises – short sprints).
30. Coaching and Tactic development of athletic events – Types of running (sprints – middle distance – long distance).
31. Coaching and Tactic development of athletic events – Start and Finish.
32. Coaching and Tactic development of athletic events – Types of Jumps (long jump, high jump, triple jump, pole vault).
33. Coaching and Tactic development of athletic events – Types of Throws (shotput, discuss throw, javelin throw, hammer throw).
34. Coaching and Tactic development of athletic events – Team events (4x100m relay, 4x400m relay) – Combined events (decathlon, heptathlon).

Semester V

Third Year		
Semester V		
1.	FSQ 3107 Food Biochemistry and Nutrition	3 (2+1)
2.	FPT 3102 Processing Technology of Cereals	3 (2+1)
3.	FPT 3103 Processing Technology of Fruits and Vegetables	3 (2+1)
4.	FPT 3104 Food Packaging Technology and Equipment	2 (1+1)
5.	FPT 3105 Processing of Spices and Plantation Crops	3 (2+1)
6.	FPE 3108 Food Storage Engineering	3 (2+1)
7.	BES 3124 Project Preparation and Management	2 (1+1)
8.	BES 3125 Agricultural Marketing and Trade	3 (2+1)
9.	FTR 3101 Study tour (10-12 days during the semester)	2 (0+2) NG
Total		**22 (14+8) + 2 (NG)**

FSQ 3107 Food Biochemistry and Nutrition 3 (2+1)

Objectives

1. Gain an understanding of nutrition and diets
2. Understand and learn metabolic pathways for different biomolecules in human body

Theory

Module I **(9 Hours)**

Concepts of Food and Nutrition; Functions of food; Basic food groups; nutrients supplied by food; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food.

Module II **(7 Hours)**

Mechanism of Enzyme action; Introduction to enzyme and characteristics, coenzymes, kinetics and mechanism of enzyme action; Derivation of Michaelis-Menten Equation, Enzyme inhibition by pH, allosteric enzymes; Nucleic acids, structures of various components of DNA and RNA.

Module III **(8 Hours)**

Nutrients; Functions, sources, digestion, absorption, assimilation, transport of carbohydrates; Functions, sources, digestion, absorption, assimilation, transport of proteins; Functions, sources, digestion, absorption, assimilation, transport of fats; Metabolism of carbohydrates. Introduction to carbohydrates metabolism, glycolysis, TCA cycle; Electron transport chain, oxidative and substrate level phosphorylation.

Module IV **(10 Hours)**

Metabolism of Lipids; Introduction to lipid metabolism, β-oxidation of long chain fatty acids, Ketosis, breakdown of phospholipids; Biosynthesis of fatty acids, triglycerides and phospholipids; Introduction to protein metabolism, transamination; Deamination and decarboxylation; Fixation of Nitrogen, Urea Cycle. Functions, sources, absorption, deficiency of macrominerals, microminerals and trace minerals; Functions, sources, absorption, deficiency of Vitamins A &D, Vitamins E and K and water-soluble vitamins Information about hormones and relation between vitamins and hormones.

Practical

Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates; Qualitative and quantitative determination of amino acids; Qualitative and quantitative determination of proteins; Qualitative and quantitative determination of lipids; Qualitative and quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pKa of acid; Determination of pi for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of protein using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of β-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.

Lecture Schedule

1. Concepts of Food and Nutrition.
2. Functions of food, Basic food groups, Nutrients supplied by food.
3. Water and energy balance, Water intake and losses.
4. Basal metabolism.
5. Formulation of diets: Classification of balanced diet and preparation of balanced diet for various groups.
6. Recommended dietary allowances for various age groups.
7. Malnutrition; Assessment of nutritional status.
8. Food fad and faddism.
9. Potentially toxic substance in human food.
10. Mechanism of Enzyme action: Introduction to enzyme and characteristics, coenzymes.
11. Kinetics and mechanism of enzyme action.
12. Derivation of Michaelis- Menten Equation.
13. Enzyme inhibition by pH and allosteric enzymes.
14. Nucleic acids.
15. Structures of various components of DNA and RNA.
16. Nutrients; Functions, sources, digestion, absorption, assimilation, transport of carbohydrates.
17. Functions, sources, digestion, absorption, assimilation, transport of proteins.
18. Functions, sources, digestion, absorption, assimilation, transport of fats.

19. Metabolism of carbohydrates.
20. Introduction to carbohydrates metabolism.
21. Glycolysis.
22. TCA cycle.
23. Electron transport chain and oxidative and substrate level phosphorylation.
24. Metabolism of Lipids; Introduction to lipid metabolism and β-oxidation of long chain fatty acids.
25. Ketosis, breakdown of phospholipids.
26. Biosynthesis of fatty acids, triglycerides and phospholipids.
27. Introduction to protein metabolism: transamination, deamination and decarboxylation.
28. Fixation of Nitrogen and Urea Cycle.
29. Functions, sources, absorption, deficiency of macrominerals.
30. Functions, sources, absorption, deficiency of microminerals and trace minerals.
31. Functions, sources, absorption, deficiency of Vitamins A &D, Vitamins E and K.
32. Functions, sources, absorption, deficiency of water-soluble vitamins.
33. Information about hormones and relation between vitamins and hormones.
34. Information about hormones and relation between vitamins and hormones.

Practical Schedule

1. Preparation of various solutions and buffers.
2. Qualitative and quantitative determination of carbohydrates.
3. Qualitative and quantitative determination of amino acids and proteins.
4. Qualitative and quantitative determination of lipids.
5. Qualitative and quantitative determination of vitamins.
6. Isolation of enzymes from various sources.
7. Measurement of energy using bomb calorimeter.
8. Determination of pKa of acid and determination of pI for casein.
9. Estimation of sugars by Anthrone method.
10. Estimation of protein by Lowry method and Biuret method.
11. Separation of amino acids using paper chromatography and thin layer chromatography.
12. Separation of amino acids using electrophoresis.
13. Estimation of phosphorus, iron and calcium content in food sample.
14. Estimation of β-carotene using column chromatography.
15. Estimation of ascorbic acid using dye method.
16. Effects of acids and alkali on pigments.
17. Practical examination.

Suggested reading

1. Berdanier, C.D., Feldman, E.B. and Dwyer, J. 2008. Handbook of Nutrition and Food, 2nd edn. CRC Press, Boca Raton, FL, USA.
2. Berg, J.M., Tymoczko, J.L., Stryer, L. and Gatto JR., G.J. 2002. Biochemistry, 7th edn. W.H. Freeman and Company, NY, USA.
3. Buchanan, B.B., Gruissem W. and Jones, R.L. 2002. Biochemistry and Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.

4. Moe, G., Kelley, D., Berning, J. and Byrd-Bredbenner, C. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. Mcgraw-Hill, Inc., NY, USA.
5. Nelson, D.L. and Cox, M.M. 2012. Lehninger Principles of Biochemistry, 6th edn. Macmillan Learning, NY, USA.
6. Voet, D. and Voet, J.G. 2011. Biochemistry, 4th edn. John Wiley and Sons, Inc., NY, USA.

FPT 3102 Processing Technology of Cereals 3(2+1)

Objectives

1. Learn milling technology of rice, wheat, corn and barley.
2. Get knowledge about breakfast cereals and their processing.

Theory

Module I **(9 Hours)**

Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets; Chemical composition and nutritive value. Paddy processing and rice milling: Conventional milling, modern milling; Milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Ageing of rice; Enrichment of rice – methods of enrichment; Rice fortification.

Module II **(6 Hours)**

Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches.

Module III **(7 Hours)**

Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses.

Module IV **(12 Hours)**

Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

Practical

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylo-graph; Processing of value-added products from millets; Visit to Cereal processing unit**.**

Lecture Schedule

1. Introduction, present, future, scope and morphology of cereals and millets.
2. Chemical composition, nutritive value and physico-chemical properties of cereals.
3. Chemical composition, nutritive value and physico-chemical properties of millets.
4. Processing of paddy, methods of milling and milling efficiency.
5. Milling machines and quality characteristics of milled products.
6. Introduction, methods, advantages and disadvantages of Parboiling.
7. Rice bran stabilization and its methods.
8. Ageing of rice, enrichment of rice and its methods.
9. Introduction to rice fortification, types, advantages and disadvantages.
10. Methods and equipment for wheat milling, Break rolls and reduction rolls.
11. Types, composition, extraction rate and quality characteristics of flour.
12. Extraction rate and its effect on flour composition.
13. Introduction, methods and process steps for baking.
14. Methods, equipment for corn milling.
15. Starch extraction and gluten separation, modified starch, resistance starch.
16. Methods, equipment for barley milling.
17. Malting and by-products of barley milling.
18. Processing methods and equipment for milling of oats.
19. Types and equipment for milling of sorghum.
20. Malting, pearling and by-products of sorghum.
21. Introduction, methods and equipment for processing of Pearl millets.
22. Introduction, methods and equipment for processing of Finger millets.
23. Secondary and tertiary products processing of cereals.
24. Secondary and tertiary products processing of millets.
25. By-products processing of cereals.
26. By-products processing of cereals.
27. By-products processing of millets.
28. By-products processing of millets.
29. Processing of infant foods from cereals.
30. Processing of infant foods from cereals.
31. Processing of breakfast cereal foods.
32. Processing of infant foods from millets.
33. Processing of flaked and puffed products-processing of expanded products and pasta.
34. Extrusion methods, advantages and types of extruder.

Practical Schedule

1. Observations of morphological characteristics of cereals.
2. Determination of physical properties of cereals.
3. Determination of chemical properties of cereals.
4. Experiment on parboiling of paddy.
5. Determination of cooking quality characteristics of rice.
6. Experiment on precondition of rice milling.
7. Experiment on wheat milling.

8. Experiment on production of sorghum flakes and malt.
9. Experiment on production of flaked rice.
10. Experiment on puffed rice.
11. Experiment on production of popcorns.
12. Experiment on production of noodles.
13. Determination of gelatinization temperature by amylograph.
14. Experiment on processing of value-added products from millets.
15. Experiment on extrusion process.
16. Visit to Cereal processing unit.
17. Practical examination.

Suggested Reading

1. Araullo, E.V., De Padua, D.B. and Graham, M. 1976. Rice Post Harvest Technology. IDRC, Canada.
2. Chakraverty, A. and Singh, R.P. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
3. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
4. Champagne, E.T. 2004. Rice: Chemistry and Technology, 3rd edn. AACC International, Inc., St. Paul, MN, USA.
5. David, A.V. Dendy and Dobraszczyk, B.J. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
6. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
7. Khan, K. and Shewry, P.R. 2009. Wheat: Chemistry and Technology, 4th edn. AACC International, Inc., St. Paul, MN, USA.
8. Matz, S.A. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
9. Wrigley, C. 2004. Encyclopaedia of Grain Science. Academic Press, London, UK.
10. White, P. J. and Johnson. L. Lawrence A. 2003. Corn: Chemistry and Technology, 2nd edn. AACC International, Inc., St. Paul, MN, USA.

FPT 3103 Processing Technology of Fruits and Vegetables 3(2+1)

Objectives

1. Understand methods of preservation of fruits and vegetables.
2. Get knowledge of FSSAI specifications of fruits and vegetables products.

Theory

Module I **(8 Hours)**

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables.

Module II **(8 Hours)**

Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching- operations and equipment; Canning: - Definition, processing steps, and equipment. Cans and containers, quality assurance and defects in canned products.

Module III **(6 Hours)**

FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products; FSSAI specifications of crystallized fruits and preserves.

Module IV **(12 Hours)**

Jam, jelly and marmalades, candies; Preparation, preservation and machines for manufacture of above products; Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, leather, dehydrated products, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products; By-products of fruit and vegetable processing industry.

Practical

Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash; Preparation of syrup; Preparation of raisins, dried fig and dried banana; Preparation of anardana, Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.

Lecture Schedule

1. Production and processing scenario of fruits and vegetables in India and world
2. Scope of fruit and vegetable processing industry in India.
3. Overview of principles and preservation methods of fruits and vegetables.
4. Supply chain of fresh fruits and vegetables.
5. Primary processing and pack house handling of fruits and vegetables.
6. Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables.
7. Minimal processing of fruits and vegetables.
8. Blanching- operations and equipment.
9. Canning- Definition, processing steps, and equipment.
10. Cans and containers, quality assurance and defects in canned products.
11. FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.
12. Processing and equipment for above products.
13. FSSAI specifications of crystallized fruits and preserves.

14. Jam: Preparation, preservation and machines for manufacture.
15. Jelly: Preparation, preservation and machines for manufacture.
16. Marmalades: Preparation, preservation and machines for manufacture.
17. Candies: Preparation, preservation and machines for manufacture.
18. Preparation, preservation and machines for manufacture of chutney.
19. Preparation, preservation and machines for manufacture of pickles.
20. Preparation, preservation and machines for manufacture of sauce.
21. Preparation, preservation and machines for manufacture of puree.
22. Preparation, preservation and machines for manufacture of paste.
23. Preparation, preservation and machines for manufacture of ketchup.
24. Preparation, preservation and machines for manufacture of toffee.
25. Preparation, preservation and machines for manufacture of cheese and leather.
26. Production of pectin.
27. Production of vinegar.
28. Preparation, preservation and machines for manufacture of dehydrated products and wafers.
29. Preparation, preservation and machines for manufacture of papads.
30. Preparation, preservation and machines for manufacture of soup powders.
31. Commercial processing technology of selected fruits for production of various value-added processed products.
32. Commercial processing technology of selected vegetables for production of various value-added processed products.
33. By-products of fruit processing industry.
34. By-products of vegetable processing industry.

Practical Schedule

1. Primary processing of selected fruits and vegetables.
2. Canning of Mango/Guava/ Papaya.
3. Preparation of jam from selected fruits.
4. Preparation of jelly from selected fruits.
5. Preparation of fruit marmalade.
6. Preparation of RTS; Preparation of squash.
7. Preparation of syrup.
8. Preparation of raisins.
9. Preparation of dried fig and dried banana.
10. Preparation of anardana, Preparation of papain.
11. Preparation of pickles.
12. Preparation of dried ginger.
13. Preparation of dried onion and garlic.
14. Preparation of banana and potato wafers.
15. Preparation of dehydrated leafy vegetables.
16. Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.
17. Practical examination.

Suggested Reading

1. Chavan, U.D. and Patil, J.V. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. Chakraverty, A. Mujumdar, A.S. Vijaya Raghavan, G.S. and Ramaswamy, Hosahalli S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. Cruess, W.V. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur. 4. Dauthy, M. E. 1995.
4. Fruit and Vegetable Processing. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome, U.D.
5. EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.
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7. Hui, Y.H., Chazala, S., Graham, D.M., K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
8. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
9. Pandey, P.H. 1997. Post-Harvest Technology of Fruits and Vegetables. SarojPrakashan, Allahabad.
10. Rajarathnam, S. and Ramteke, R.S. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.
11. Srivastava, R.P. and Kumar, S. 2002. Fruit and Vegetable Preservation: Principles and Practices, 3rd edn. International Book Distribution Co., Delhi.
12. Thompson, A.K. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd edn. Blackwell Publishing Ltd., Oxford, UK.

FPT 3104 Food Packaging Technology and Equipment 2(1+1)

Objectives

1. Understand Concept of Packaging, Its Type and Properties of Packaging Materials.
2. Gain Knowledge about Intelligent, Smart, and Active Packaging.
3. Learn Labelling requirements and Regulations

Theory

Module I **(4 Hours)**

Packaging situations in World and India; Need of packaging; Package requirements, package functions; Properties of different packaging materials; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminum/ tin/SS) as package material-manufacture, advantages, disadvantages.

Module II **(5 Hours)**

Plastic as package material, classification of polymers, properties of each plastics, uses of each plastics Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging; Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods.

Module III **(8 Hours)**

Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging; Edible packaging- Types and sources; Microwavable packaging – Types and applications. Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package. Packaging practices followed for fruits and vegetables and their products, packaging machines, Filling machines, vacuum packaging machines. Bottle fillers, fillers for dry mixers, ice-cream fillers, Form fill and seal (FFS) machines, vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system; Labelling requirements, methods of coding and regulation and standards of labelling of food packages.

Practical

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers; Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of lacquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

Lecture Schedule

1. Introduction to packaging- Packaging situations in World, India - Need of packaging.
2. Package requirements, package functions - properties of different packaging materials.
3. Package materials - Classification of packages, paper as package material, its manufacture-types, advantages of corrugated and paper board boxes, etc.
4. Glass as package material - manufacture, advantages, disadvantages.
5. Metal (Aluminium/ tin/ SS) as package material-manufacture, advantages, disadvantages.
6. Plastic as package material - classification of polymers, properties of each plastics - uses of each plastic.
7. Lamination: Moulding-Injection, blow, extrusion - Coating on paper and films.
8. Aseptic packaging- Need, advantages, process, comparison of conventional and aseptic packaging - system of aseptic packaging and materials used in aseptic packaging.

9. Permeability - Theoretical considerations, permeability of gases and vapours - Permeability of multilayer materials- Permeability in relation to packaging requirement of foods.
10. Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP, Retort structure and packaging.
11. Edible packaging- Types and sources; Microwavable packaging - Types and applications.
12. Transport properties of barriers- Simulations of product- Package environment interaction.
13. Packaging of specific foods- mechanical and functional tests on package.
14. Packaging practices followed for fruits and vegetables and their products.
15. Packaging machines - Filling machines, vacuum packaging machines - Bottle fillers, fillers for dry mixers, ice-cream fillers - Form fill and seal (FFS) machines.
16. Vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system.
17. Labelling requirements - methods of coding and regulation and standards of labelling of food packages.

Practical Schedule

1. Classification of various packages based on material and rigidity.
2. Measurement of thickness of paper, paper boards.
3. Measurement of basic weight and grammage of paper and paperboards.
4. Measurement of water absorption of paper, paper boards.
5. Measurement of bursting strength of paper, paper boards.
6. Measurement of tear resistance of papers.
7. Measurement of puncture resistance of paper and paperboard.
8. Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers.
9. Determination of gas and water transmission rate of package films.
10. Determination of lacquer integrity test.
11. Drop test, Box compression test.
12. Identification of plastic films.
13. Determination of seal integrity, ink adhesion.
14. Packaging practices followed for packing fruits and vegetables.
15. Shelf-life calculations for food products; Head space analysis of packaged food.
16. Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.
17. Practical examination.

Suggested Reading

1. Ahvennainen, R. 2003. Novel Food Packaging Techniques. CRC-Woodhead Publishing Ltd., Cambridge, England.
2. Coles, R., McDowell, B. and Kirwan, M.J. 2003. Food Packaging Technology. Blackwell

a. Publishing Ltd., Oxford, UK.

3. Han, J. H. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
4. Han, J.H. 2005. Innovations in Food Packaging. Elsevier Science and Technology Books, UK.
5. Lee, D. S. 2008. Food Packaging Science and Technology. CRC Press, Boca Raton FL, USA.
6. Robertson, G. L. 2014. Food Packaging: Principles and Practice, 3rd edn. CRC Press, Boca Raton, FL, USA.
7. Robertson, G. L. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.

FPT 3105 Processing of Spices and Plantation Crops 3(2+1)

Objectives

1. Learn processing technology of different spices.
2. Understand post-harvest technology of tea, coffee, cocoa etc.

Theory

Module I **(2 Hours)**

Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition.

Module II **(17 Hours)**

Processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Equipment for cryogenic grinding; Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon; Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram; Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves.

Module III **(10 Hours)**

Postharvest technology for Tea, coffee, cocoa, Vanilla and annatto processing; Post-harvest technology and processing of areca nut, cashew nut, oil palm, coconut.

Module IV **(5 Hours)**

Flavours of minor spices; Flavour of major spices. Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices. Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization. Functional packaging of spices and spice products; By-products of plantation crops and spices.

Lecture Schedule

1. Production and processing scenario of spice, flavour and plantation crops and its scope.
2. Post-harvest technology and composition of major spices.
3. Unit operations in spice processing-cleaning, drying, milling, and grading.

4. Processing of Ginger -flow chart-various products, Processing of chilli- drying-dryers, value added products.
5. Processing of turmeric- boiling and polishing-drying methods-equipment and operation.
6. Processing of onion - drying methods-value added products.
7. Processing of garlic.
8. Processing of pepper- value added products-flow chart-packaging methods.
9. Processing of cardamom- stages of harvest-cleaning, drying, grading equipment-cryogenic grinding.
10. Processing and utilization of Minor spices-herbs, leaves and spartan seasonings.
11. Aniseed, Sweet basil-composition and its utilization.
12. Caraway seed, cassia and cinnamon-composition and its utilization.
13. Processing of Clove-stages of harvest-cleaning, drying, grading equipment.
14. Coriander-uses, harvesting, drying.
15. Processing of cumin, dill seed -types, harvesting, drying.
16. Processing of fennel seed and its utilization.
17. Processing of nutmeg and mace.
18. Processing of mint-harvesting, drying, storage.
19. Processing of marjoram and rosemary, saffron-production flow chart.
20. Sage herb, thyme, ajwain, asafoetida, curry leaves-harvesting, drying, preservation, uses.
21. Plantation crops-classification-production & processing-Status and Exports.
22. Processing of Tea-unit operation-flow chart, process and equipment.
23. Processing of coffee-Dry and wet processing-Green and cherry Coffee,Unit operation-flow charts-equipment and operation.
24. Instant coffee powder-flow chart-byproduct utilization of coffee industry.
25. Processing of Cocoa-Important unit operation.
26. Flow charts in cocoa processing-Equipment-Chocolate processing-flow charts.
27. Processing of vanilla and annatto-flowchart, utilization.
28. Processing of arecanut-different products-unit operation-flow chart equipment and operation.
29. Processing of cashew nut-unit operations-flow chart.
30. Processing of oil palm and coconut-unit operations-flow chart.
31. Flavour extraction from spices-minor spices and major spices.
32. Extraction of oleoresins and essential oils from medicinal plants and spices-steam distillation and Super critical fluid extraction of spices.
33. Standards - ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization.
34. Packaging of spices and spice products-materials-methods-packaging equipment; By-products of plantation crops and spices.

Practical Schedule

1. Identification and characterization of flavouring compounds of spices.
2. Valuable oil determination.
3. Extraction of oil from clove, pepper, cardamom, chilli.

4. Extraction of oleoresins: Turmeric, ginger.
5. Extraction of oleoresins: pepper, clove.
6. Piperine estimation in pepper oleoresin.
7. Steam distillation of spices.
8. Determination of curcumin content in turmeric.
9. Determination of Moisture content in spices.
10. Determination of refractive index and acid value in spices.
11. Determination of specific gravity of spices.
12. Packaging study of spices.
13. Preparation of curry powder.
14. Study of standard specification of spices.
15. Microwave assisted extraction of spice oil.
16. Visit to a spice processing industry.
17. Practical examination.

Suggested Reading

1. Gupta, S. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
2. Hirasa, K. and Takemasa, M. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
3. Panda, H. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
4. Pruthi, J.S. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
5. Pruthi, J.S. 2001. Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.
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7. Shanmugavelu, K.G. Spices and Plantation Crops. Oxford and IBH Publishing Co., New Delhi.

FPE 3108 Food Storage Engineering 3(2+1)

Objectives

1. Understand storage structure for grains and other perishables.
2. Learn the design of storage structure.

Theory

Module I **(8 Hours)**

Introduction: Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis; Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control.

Module II **(8 Hours)**

Storage structures: Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; Storage of grains: Respiration of grains, moisture and temperature changes in stored grains; Conditioning of environment inside storage through ventilation.

Module III **(9 Hours)**

Aeration and stored grain management: Purposes of aeration, aeration theory, aeration system design, aeration system operation; Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control; Storage of perishables: Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage.

Module IV **(9 Hours)**

Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.

Practical

Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

Lecture Schedule

1. Storage –introduction- importance of scientific storage systems.
2. Post-harvest physiology of semi-perishables and perishables.
3. Climacteric and non-climacteric fruits -respiration.
4. Ripening– changes during ripening– ethylene bio-synthesis.
5. Damages during storage–direct damages– indirect damages.
6. Causes of spoilage during storage– physiological and environmental factors–remedies.
7. Factors affecting spoilage in storage –moisture– temperature– humidity– respiration loss, heat of respiration– sprouting.
8. Destructive agents–rodents– birds–insects.
9. Source of infestation and control.
10. Storage structures– traditional storage structures.

11. Improved storage structures- different types.
12. Modern storage structures- different types.
13. Farm silos–horizontal silos– tower silos– pit silos– trench silos– size and capacity of silos.
14. Storage of grains– respiration of grains.
15. Moisture and temperature changes in stored grains.
16. Conditioning of environment inside storage through ventilation.
17. Aeration and stored grain management - purposes of aeration–aeration theory.
18. Aeration system design and operation.
19. Damage due to insects, pests and rodents during storage– its control– seed coating.
20. Damage due to rodents during storage– its control.
21. Fumigations – common fumigants-methods of application.
22. Storage of perishables– conditions for storage of perishable products.
23. Cold storage – design considerations-requirement.
24. Modified atmosphere storage of grains – concept – construction and operation.
25. MA storage-selection of gases – mixing and controlling – advantages – structure requirement.
26. Controlled atmospheric storage– concepts– gases used–effect of gases– mixing of gases– requirements.
27. Conditions for storage of perishable products.
28. Hypobaric storage–concept – principle –requirements.
29. Evaporative cooling - principles and concept – requirement.
30. Evaporative cooling - types - construction and operation.
31. Design of storage structures–pressure theories–pressure distribution in the bin.
32. Grain storage loads– pressure and capacities.
33. Warehouse and silos– concept– structure.
34. BIS specifications– functional– structural and thermal design of cold stores.

Practical Schedule

1. Layout design, sizing, capacity and drawing of traditional storage structures.
2. Visits to traditional storage structures.
3. Measurement of respiration of fruits/grains in the laboratory.
4. Study on aeration systems inside storage structure.
5. Study on fumigation.
6. Visits to FCI godowns.
7. Design of grain godowns for particular capacity and commodity.
8. Drawing and layout of grain godown for particular commodity and capacity.
9. Visits to cold storage.
10. Design of cold storage for particular capacity and commodity.
11. Drawing and layout of cold storage for particular commodity and capacity.
12. Visits to CA storage.
13. Design of CA storage for particular capacity and commodity.
14. Drawing and layout of CA storage for particular commodity and capacity.
15. Visits to evaporative cooling system for storage.
16. Storage study in the MAP.

17. Practical Examination.

Suggested Readings

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brooker, D. B., Bakker-Arkema, F. W. and Hall, C. W. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
3. Hall, C. W. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
4. Jayas, D.S., White N.D.G. and Muir, W.E. 1994. Stored Grain Ecosystems. Marcel Dekker, New York.
5. Kutz, M. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
6. Michael, A.M. and Ojha, T. P. 2004. Principals of Food Technology, Vol.I. Jain Brothers, New Delhi.
7. Newbaver, L.W. and Walker, H.B. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
8. Pandey, H., Sharma, H. K., Chauhan, R. C., Sarkar, B. C. and Bera, M. B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt. Ltd.
9. Pandey, P. H. 1997. Post-Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.

BES 3124 Project Preparation and Management 2(1+1)

Objectives

1. Understand concepts of project management.
2. Develop knowledge to develop a project plan and its analysis.

Theory

Module I **(3 Hours)**

Project and project management, evolution of project management, forms and environment of project management, project life cycle

Module II **(8 Hours)**

Project identification, screening, project appraisal, project selection, project proposal, and project scope. Project planning, work breakdown structure, and network scheduling. Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), time-cost relationship in a project. Resource considerations in projects, resource profiles, resource leveling, and limited resource allocation.

Module III **(3 Hours)**

Project implementation, monitoring, and control. Project management process and the role of the project manager, team building, leadership in projects, organizational and behavioral issues in project management.

Module IV **(3 Hours)**

Project monitoring and control, project completion, and review. Recent trends and future directions in project management. Use of computers in project management.

Practical

Brainstorming exercise to identify a set of projects and their evaluation; work break down structure for different projects; Network Scheduling and Drawing network charts for different projects; Formulation of CPM scheduling for a specific project; Formulation of PERT scheduling for a specific project; Reduction of Project Duration: Time/cost trade off; Resource Profiles and levelling, PERT/Cost Method, Earned value analysis.

Lecture Schedule

1. Introduction to Projects and Project Management, Evolution of Project Management.
2. Forms and Environment of Project Management.
3. Project Life Cycle.
4. Project Identification and Screening.
5. Project Appraisal, Selection, Proposal and Project Scope.
6. Project Planning - Work Breakdown Structure (WBS).
7. Network Scheduling Techniques.
8. Critical Path Method (CPM).
9. Program Evaluation and Review Technique (PERT).
10. Time-Cost Relationship in Projects.
11. Resource Considerations in Projects-Resource Leveling and Allocation.
12. Project Implementation -Monitoring and Control in Projects.
13. Project Management Process-Role of the Project Manager Team Building and Leadership in Projects.
14. Organizational and Behavioral Issues in Project Management.
15. Project Completion and Review.
16. Recent Trends and Future Directions in Project Management.
17. Computers in Project Management.

Practical Schedule

1. Brainstorming Exercise to Identify Projects.
2. Brainstorming Exercise to Identify Projects.
3. Work Breakdown Structure (WBS) Development.
4. Network Scheduling and Drawing Network Charts.
5. Formulation of CPM Scheduling.
6. Formulation of PERT Scheduling.
7. Project evaluation case study-CPM.

8. Project evaluation case study-PERT.
9. Reduction of Project Duration: Time/Cost Trade-off.
10. Resource Profiles and Leveling.
11. PERT/Cost Method Analysis.
12. PERT/Cost Method Analysis.
13. Earned Value Analysis.
14. Case study – Identify Projects related to Food Industry.
15. Case study – Analyse Projects related to Food Industry.
16. Case study – Evaluate Projects related to Food Industry.
17. Practical examination.

Suggested Reading

1. Chandra, P. 1980. Projects- Preparation, Appraisal, Budgeting and Implementation. Tata McGraw-Hill Publication, New Delhi.
2. Chandra, P. 2014. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.
3. Gopalakrishnan, P. and Rama Moorthy, V.E. 2014. Textbook of Project Management. Laxmi Publications Pvt. Limited
4. Kerzner, H. 2006. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers and Distributors.
5. Nicholas, J.M. 2005. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
6. Panneerselvam, R. 2004. Operations Research, 2nd edn. International Book House, Mumbai.

BES 3125 Agricultural Marketing and Trade 3(2+1)

Objectives

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

Theory

Module I **(7 Hours)**

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 agricultural commodities. Nature and determinants of demand and supply of farm products. Producer's surplus – meaning and its types, marketable and marketed surplus. Factors affecting the marketable surplus of agricultural commodities.

Module II **(4 Hours)**

Pricing considerations and approaches – cost-based and competition-based pricing. Market promotion – advertising, personal selling, sales promotion, and publicity. Meaning, merits, and demerits of these promotional methods.

Module III **(8 Hours)**

Marketing process concentration, dispersion, and equalization. Exchange functions – buying and selling. Physical functions – storage, transport, and processing. Facilitating functions – packaging, branding, grading, quality control, and labelling (Agmark). Market functionaries and marketing channels. Types and importance of agencies involved in agricultural marketing. Meaning and definition of marketing channels, number of channel levels, and marketing channels for different farm products.

Module IV **(9 Hours)**

Meaning, definition, and types of market integration. Marketing efficiency. Marketing costs, margins, and price spread. Factors affecting the cost of marketing. Reasons for higher marketing costs of farm commodities. Ways of reducing marketing costs. Role of the government in agricultural marketing. Public sector institutions – CWC, SWC, FCI, CACP, and DMI – their objectives and functions. Cooperative marketing in India. Risk in marketing, types of risk, speculation and hedging, and an overview of futures trading. Agricultural prices and policy. Meaning and functions of price, administered prices, and the need for innovations in agricultural price policy.

Module V **(6 Hours)**

Concept of international trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agricultural commodities. WTO, Agreement on Agriculture (AoA) and its implications on Indian agriculture, and intellectual property rights (IPR). 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.

Lecture Schedule

1. Introduction to Agricultural Marketing.
2. Market Structure and Marketing Mix.
3. Market Segmentation in Agricultural Marketing.

4. Classification and Characteristics of Agricultural Markets.
5. Demand and Supply of Agricultural Commodities.
6. Producer's Surplus: Concepts and Types.
7. Factors Affecting Marketable Surplus.
8. Pricing Strategies in Agricultural Marketing -cost-based and price-based.
9. Promotion Strategies in Agricultural Marketing- advertising, personal selling, sales promotion, and publicity.
10. Sales Promotion in Agricultural Marketing.
11. Meaning, merits, and demerits of these promotional methods.
12. Marketing Process: Concentration, Dispersion, and Equalization.
13. Exchange Functions in Agricultural Marketing.
14. Physical Functions in Agricultural Marketing.
15. Facilitating Functions in Agricultural Marketing -packaging, branding, grading, quality control, and labeling (Agmark).
16. Types and importance of agencies involved in agricultural marketing.
17. Market Functionaries and Marketing Channels.
18. Meaning and definition of marketing channels, number of channel levels.
19. Marketing Channels for Different Farm Products.
20. Market Integration: Meaning and Types.
21. Marketing Efficiency and Its Measurement.
22. Marketing Costs and Margins.
23. Price spread in Agricultural Marketing.
24. Reasons for higher marketing costs of farm commodities and ways of reducing marketing costs.
25. Role of Government in Agricultural Marketing - Public sector institutions -objectives and functions.
26. Cooperative Marketing in India.
27. Risk in Agricultural Marketing -types of risk, speculation and hedging, and an overview of futures trading.
28. Agricultural Prices and Policy – need of innovations in Agricultural Price Policy.
29. International Trade in Agricultural Commodities -WTO and Agriculture.
30. Intellectual Property Rights (IPR) in Agriculture.
31. Role of Agricultural Produce Market Committees (APMCs).
32. Challenges, opportunities and emerging trends in Agricultural Marketing.
33. Government Initiatives to Promote Agricultural Marketing.
34. Case Study: Agricultural Marketing in India.

Practical Schedule

1. Plot the demand and supply curves for selected agricultural commodities and interpret the shifts.
2. Calculate price elasticity of demand and supply for selected agricultural products and analyze the results.
3. Collect data on market arrivals and prices for selected commodities and analyze their relationship.

4. Compute marketable and marketed surplus for key agricultural commodities and identify the factors affecting them.
5. Collect and analyze price trends of selected commodities over a period of time.
6. Construct index numbers to analyze price changes for selected agricultural products.
7. Visit a local agricultural market to observe the marketing functions and agencies involved.
8. Identify and map marketing channels for selected agricultural products in the local market.
9. Collection of data regarding marketing costs, margins, and price spread and presentation of report in the class.
10. Visit NAFED/State Warehousing Corporation (SWC) to study their organization, functioning, and contribution to agricultural marketing.
11. Assess the level of market integration for a specific commodity by collecting data on market prices from different regions.
12. Analyze the marketing efficiency of a selected agricultural product using real market data.
13. Study how speculation and hedging are used in agricultural markets and explore futures trading for price risk management.
14. Visit a cooperative marketing society to observe its operations and understand its role in the agricultural marketing system.
15. Identify the different risks involved in agricultural marketing and develop risk mitigation strategies for a selected commodity.
16. Study the price spread for a selected agricultural product from producer to consumer, and identify the factors contributing to the price spread.
17. Study the principle of comparative advantage in agricultural commodity trade and analyze its practical applications.
18. Study the various market functionaries involved in agricultural marketing and their roles in the market chain.

Suggested Reading

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

Semester VI

S. No.	Course Title	Credit Hours
1.	FSQ 3208 Food Additives and Preservatives	2 (1+1)
2.	FPT 3206 Sensory Evaluation of Food Products	2 (1+1)
3.	FPT 3207 Processing Technology of Legumes and Oilseeds	3 (2+1)
4.	FPE 3209 Food Refrigeration and Cold Chain	3 (2+1)
5.	FPT 3208 Processing of Meat, Fish and Poultry Products	3 (2+1)
6.	FPT 3209 Processing Technology of Beverages	3 (2+1)
7.	FPT 3210 Bakery, Confectionery and Snack Products	3 (2+1)
8.	FPT 3211 Processing Technology of Liquid Milk	2 (1+1)
Total		**21 (13+8)**

FSQ 3208 Food Additives and Preservatives 2 (1+1)

Objectives

1. Understand types of food additives and their mechanism
2. Differentiate between natural and synthetic additives

Theory

Module I **(7 Hours)**

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 colour; Processing of natural and artificial food colorants, flavours, emulsifiers, sweeteners.

Module II **(7 Hours)**

Food preservatives and their chemical action. Role and mode of action of salts, Role and mode of action of Class I and Class II preservatives; chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners

Module III **(3 Hours)**

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); Quantitativeestimation of added dyes; Isolation and identification of naturally occurring food pigments by paperand 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 infruit juices; Role and mode of antioxidant in frozen fish; Role of leaving agent in baked food product;Preservation of coconut shreds using humectants.

Lecture Schedule

1. Food additives-definition-E Number-Intentional and unintentional food additives.
2. Toxicology-threshold limits-safety evaluation of food additives.
3. Naturally occurring food additives.
4. Food colors and dyes-types.
5. Regulatory aspects of dyes, food color (natural and artificial).
6. Role of pigments - their importance and utilization as food color.
7. Processing of natural and artificial food colorants, flavours, emulsifiers, sweeteners.
8. Processing of natural and artificial food colorants, flavours, emulsifiers, sweeteners.
9. Food preservatives-types and their chemical action.
10. Role and mode of action of salts, chelating agents.
11. Importance of stabilizers and thickeners in processed foods.
12. Humectants/polyhydric alcohol, anti-caking agent.
13. Firming agents, flour bleaching and maturing agents.
14. Antioxidants-types, sweeteners-types.
15. Production of enzymes-its role, leavening agents, fat substitutes.
16. Flavor - types and taste enhancers in food processing.
17. Acidity regulators and Emulsifiers-types.

Practical Schedule

1. Evaluation of GRAS aspect of food additives.
2. Estimation of chemical preservatives by TLC (organic).
3. Estimation of chemical preservatives by TLC (inorganic).
4. Identification of food colour by TLC (organic).
5. Identification of food colour by TLC (inorganic).
6. Quantitative estimation of added dyes.
7. Isolation and identification of naturally occurring food pigments by paper chromatography.
8. Isolation and identification of naturally occurring food pigments by Thin Layer Chromatography.
9. Role and mode of action of chelating agent in fruit juice.
10. Role and mode of action of stabilizers frozen dairy products (ice-cream).
11. Role and mode of action of thickeners in frozen dairy products (ice-cream).
12. Role and mode of clarifying agent in fruit juices.
13. Role and mode of antioxidant in frozen fish.
14. Role of leaving agent in baked food product.
15. Preservation of coconut shreds using humectants.
16. Study on sequestrants and their role in processed foods.
17. Practical examination.

Suggested Reading

1. Belitz, H.-D., Grosch, W. and Schieberle, P. 2009. Food Chemistry, 4th edn. Springer-VerlagBerlin 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.

FPT 3206 Sensory Evaluation of Food Products 2(1+1)

Objectives

1. Understand basic concepts of sensory evaluation.
2. Gain knowledge about consumer study.

Theory

Module I **(6 Hours)**

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation; Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other. Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes.

Module II **(5 Hours)**

Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests.

Module III **(6 Hours)**

Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures. Descriptive sensory analysis, contour method, other procedures; Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

Practical

Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo-trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, scorecards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

Lecture Schedule

1. Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects.
2. Factors affecting food acceptance. Terminology related to sensory evaluation.
3. Principles of good practice: Requirements of sensory evaluation, sampling procedures, sensory testing environment, test protocol considerations.
4. Basic principles of Senses and sensory perception - Physiology of sensory organs.
5. Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses.
6. Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes.
7. Flavour: Definition and its role in food quality; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction.
8. Factors influencing sensory measurements-Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation.
9. Correlation of sensory and instrumental analysis.
10. Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests.
11. Application of sensory testing quality Evaluations: sensory evaluation in food product development, sensory evaluation in quality control.
12. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges.
13. Discrimination (difference tests)-directional difference test, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures.
14. Descriptive sensory analysis, contour method, other procedures.
15. Consumer measurement: objectives of consumer preference studies.
16. Information obtained from consumer study, factors influencing results from consumer surveys, methods of approach.
17. Development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

Practical Schedule

1. Determination of threshold value for basic tastes.
2. Odour recognition.
3. Study on difference test (PC, Duo-trio, triangle).
4. Determination of threshold value for various odours.
5. Study on Selection of judging panel.
6. Study on Training of judges.
7. Recognition of certain common flavour and texture defects using different types of sensory tests.
8. Study on Descriptive analysis methodology.
9. Sensory evaluation of various food products using different scales, score cards and tests.
10. Sensory evaluation of various food products using different scales, score cards and tests.
11. Texture profile methodology.
12. Estimation of color of products.
13. Subjective methods- application.
14. Objective methods – application.
15. Relationship between objective and subjective methods.
16. Designing a sensory laboratory.
17. Practical examination.

Suggested Reading

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Jellinek, G.1985.Sensory Evaluation of Food-Theory and Practice. Ellis Horwood.
4. Lawless, H.T. and Klein, B. P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker.
5. Lawless, H.T. and Heymann. H. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd edn. Springer, New York or Dordrecht Heidelberg, London.
6. Macrae, R., Robinson, R.K. and Sadler, M. J. 1994. Encyclopedia of Food Science and Technology and Nutrition. Vol. XI. Academic Press.
7. Moskowitz, H. R. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
8. Piggot, J. R. 1984. Sensory Evaluation of Foods. Elsevier Science and Technology.
9. Potter, N. N. and Hotchleiss, J. H. 1995. Food Science, 5th edn. CBS Publishers, Delhi.
10. Rai, S. C. and Bhatia, V. K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
11. Stone, H. and Sidel, J. L. 1985. Sensory Evaluation Practices. Academic Press, London.

FPT 3207 Processing Technology of Legumes and Oilseeds 3 (2+1)

Objectives

1. Understand the nutritional value and composition of legumes and oil seeds.
2. Gain knowledge about milling of pulse and oil seeds.

Theory

Module I **(6 Hours)**

Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti-nutritional compounds.

Module II **(9 Hours)**

Pulse milling: home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition.

Module III **(9 Hours)**

Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; De-solventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls.

Module IV **(10 Hours)**

Hydrogenation of oils; new technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

Practical

Determination of physical properties of legumes and oil seeds; Determination of proximate composition of selected pulses and oilseeds; Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill; Study of mini oil mill; Preconditioning of pulses before of mini oil mill; Preconditioning of pulses before milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal; Processing of composite legume mix and preparation of value added products; Visit to commercial dhal mills and oil mills.

Lecture Schedule

1. Introduction, Present, future, scope and morphology of legumes and oilseeds.
2. Chemical composition, nutritive value and physico-chemical properties of legumes.
3. Chemical composition, nutritive value and physico-chemical properties of oil seeds.
4. Classification and types of legumes and oilseeds.
5. Types, composition and removal of antinutritional factors in legumes and oilseeds.
6. Types and methods of pulse milling.
7. Types of milling industry and equipment for milling pulse milling.
8. Quality and efficiency of milling, factors affecting milling quality.
9. Problems in dhal milling industry.
10. Nutritional changes during soaking and sprouting of pulses.
11. Methods, and Cooking quality of dhal.
12. Quick and instant dhal, factors affecting cooking of dhal.
13. Composition and Processing of Soybean.
14. Soybean milk processing.
15. Value added products of soybean.
16. Types and processing of fermented products of legumes.
17. Introduction, types, methods of oil seed extraction.
18. Traditional methods of oil seed milling, ghanis and hydraulic presses.
19. Extraction of oil seed by screw expellers and its advantages and disadvantages.
20. Extraction of oil seed by solvent extraction methods.
21. Equipment, milling quality, milling efficiency, factors affecting milling quality of oil seeds.
22. Problems in oil milling industry.
23. Introduction and processing steps of refining of oil seeds.
24. Processing steps of refining of oil seeds.
25. Principles and process controls - Hydrogenation of oils.
26. New technologies in oilseed processing, supercritical fluid extraction and enfluage.
27. New technologies in oilseed processing, steam distillation and expression.
28. Definition, methods and types of leaching.
29. Utilization of oil seed meals for different food uses.
30. High protein products like protein concentrates and isolates.
31. By-products of pulse milling.
32. By-products of oil seed milling.
33. Quality characters of oil and oil products.
34. Rancidity, hydrogenation peroxidation and storage stability of oils.

Practical Schedule

1. Determination of physical properties of legumes and oil seeds.
2. Determination of proximate composition of selected pulses.
3. Determination of proximate composition of selected oilseeds.
4. Determination of nutritional quality of selected pulses.
5. Determination of nutritional quality of selected oilseeds.

6. Experiment on study of mini dhal mill.
7. Experiment on Study of mini oil mill.
8. Experiment on preconditioning of pulses before mini oil mill and milling.
9. Experiment on wet of pulses.
10. Removal of anti-nutritional compounds from selected pulses and oilseeds.
11. Experiment laboratory milling of selected pulses and its quality evaluation.
12. Experiment on laboratory milling of selected oilseeds and its quality evaluation.
13. Experiment on laboratory hydrogenation of selected oils.
14. Experiment study of cooking quality of dhal.
15. Experiment on preparation of value-added products legume products.
16. Visit to commercial dhal mills and oil mills.
17. Practical examination.

Suggested Reading

1. Chakraverty, A. 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc.,NY, USA.
3. Gunstone, F.D. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
4. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
5. Shahidi, F. 2005. Bailey's Industrial Oil and Fat Products, 6thedn., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.

FPE 3209 Food Refrigeration and Cold Chain 3(2+1)

Objectives

1. Understand the concept of refrigeration system, refrigerant and their properties
2. Design of cold storage and air conditioning systems for food storage application

Theory

Module I **(7 Hours)**

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; plug and chill type refrigeration based on chemicals.

Module II **(6 Hours)**

Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry v/s wet compression, throttling v/s isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle.

Module III **(11 Hours)**

Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine; water/lithium bromide and ammonia/water absorption cooling. Common refrigerants and their properties: Classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; Azeotrope refrigerants. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture: Principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations.

Module IV **(10 Hours)**

Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display. Low temperature refrigeration: Cryogenic fluid and fluid properties; Liquefaction; Application in food. Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air conditioning systems; humidifiers and dehumidifiers; Cooling/Refrigeration load calculations: Load sources, product cooling, conduction heat load, convection heat load, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.

Practical

Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods; Study of spray freezing process for foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice-cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of deep

freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.

Lecture Schedule

1. Refrigeration- introduction- definition- principle- background with second law of thermodynamics.
2. Application of second law of thermodynamics- refrigerator- unit of refrigeration- coefficient of performance.
3. Production of low temperatures- expansion of a liquid with flashing- reversible/ irreversible adiabatic expansion of a gas/ real gas.
4. Thermoelectric cooling- adiabatic demagnetization.
5. Carnot cycle- reversed Carnot cycle- selection of operating temperatures.
6. Air refrigerators- Bell Coleman cycle- Reversed Brayton- Joule or Bell Coleman cycle.
7. Analysis of gas cycle- polytropic and multistage compression- plug and chill type refrigeration based on chemicals.
8. Vapour refrigeration- reversed Carnot cycle with p-V and T-s diagrams limitations of reversed Carnot cycle.
9. Modifications in reverse Carnot cycle with vapour as a refrigerant.
10. Dry Vs wet compression- effects.
11. Throttling Vs isentropic expansion.
12. Vapour compression system- representation of vapour compression cycle- pressure-enthalpy diagram- super heating- sub cooling.
13. Vapour compression system- effect of suction vapour super heat and liquid sub cooling- actual vapour compression cycle.
14. Vapour absorption refrigeration system- process, calculations, maximum coefficient of performance of a heat operated refrigerating machine.
15. Water/lithium bromide and ammonia/water absorption cooling
16. Common refrigerants and their properties- classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical- azeotrope refrigerants.
17. Components of vapour compression refrigeration system and their classifications- evaporator, compressor, condenser and expansion valve.
18. Components of vapour compression refrigeration system and their classifications- evaporator, compressor, condenser and expansion valve.
19. Ice manufacture- principles and systems of ice production, basic types of ice, ice makers.
20. Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice.
21. Cold storage- cold store, types.
22. Different components of cold storage.
23. Design of cold storage for different categories of food resources, size and shape.
24. Construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations.
25. Refrigerated transport: Handling and distribution.
26. Cold chain, refrigerated product handling and order picking.

27. Refrigerated vans, refrigerated display.
28. Low temperature Refrigeration- cryogenic fluid and fluid properties- liquefaction-application in food.
29. Air-conditioning-principles- functions-factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning.
30. Air-conditioning- problems on sensible heat factor.
31. Winter/summer/year-round air-conditioning, unitary air-conditioning systems, central air-conditioning.
32. Physiological principles in air-conditioning, air distribution and duct design methods
33. Design of complete air conditioning systems- humidifiers and dehumidifiers
34. Cooling/Refrigeration load calculations: Load sources, product cooling, conduction heat load, convection heat load, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.

Practical Schedule

1. Study of vapour compression refrigeration system.
2. Determination of COP of vapour compression refrigeration system.
3. Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems.
4. Study of refrigerants, their properties and charts.
5. Study of direct and indirect contact freezing equipment for foods.
6. Study of spray freezing process for foods.
7. Study of food cold storage.
8. Estimation of refrigeration load for cold storage.
9. Estimation of refrigeration load for meat and poultry products.
10. Study of refrigeration system of dairy plant.
11. Estimation of refrigeration load for ice-cream.
12. Study of cooling system for bakery and estimation of refrigeration loads.
13. Estimation of refrigeration load during chocolate enrobing process.
14. Study of refrigerated van.
15. Study of deep freezing and thawing of foods.
16. Study of refrigerated display of foods and estimation of cooling load.
17. Practical Examination.

Suggested Readings

1. ASHARE Handbook, 2006: Refrigeration.
2. Arora, C.P. 2000. Refrigeration and Air Conditioning, 2nd edn. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
4. Stoecker, W.F. and Jones, J.W.1982. Refrigeration and Air Conditioning, 2nd edn. McGraw-Hill Book Co., New York, USA.
5. Whitman, W.C., Johnson, W.M., Tomczyk, J.A. and Silberstein, E. 2009. Refrigeration and Air Conditioning Technology, 6th edn. Delmar, Cengage Learning, NY, USA.

FPT 3208 Processing of Meat, Fish and Poultry Products 3 (2+1)

Objectives

1. Understand types of meat and the unit operations in meat, fish and poultry processing.
2. Gain knowledge about various methods of preservation of meat, fish, poultry and their products.

Theory

Module I **(12 Hours)**

Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish. Structure and composition of muscle, types, classification and composition of fish, Preslaughter operations and slaughtering operations for animals and poultry. Dressing and evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat.

Module II **(10 Hours)**

Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for meat, poultry and fish, Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Meat quality parameters – color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation.

Module III **(2 Hours)**

Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products; Problems on mass balancing of ingredients in formulation of value-added meat products; Abattoir design and layout.

Module IV **(9 Hours)**

Preservation of fresh fish, characteristic of fresh fish and fermented and value added products of fish; Spoilage indices of fish and factors affecting the spoilage of fish; Eggs: Structure, composition, quality characteristics, defects and grading of egg processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties, Preparation protocols of indigenous products: Fish sauce and paste; By-products of meat, poultry, fish and eggs and their utilization; Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI/ Kosher/Halal, EU hygienic regulations and ISO 9000 standards.

Practical

Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals; Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration; Evaluation of quality and grading of eggs; Preservation of shell eggs; Preparation of value-added poultry meat products; Value added egg products; Visit to abattoir. Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Visit to fish and prawn processing industry.

Lecture schedule

1. Status of meat poultry and fish industry in India.
2. Sources and importance of meat, poultry and fish.
3. Structure and composition of muscle, types, classification and composition of fish.
4. Preslaughter operations and slaughtering operations for animals and poultry.
5. Dressing and evaluation of animal carcasses.
6. Factors affecting post-mortem changes, properties and shelf life of meat.
7. Mechanical deboning, grading and aging.
8. Eating and cooking quality of meat.
9. Preservation of meat, poultry and fish by chilling, freezing, pickling.
10. Preservation of meat, poultry and fish by curing, cooking and smoking, canning.
11. Preservation of meat, poultry and fish by dehydration, radiation, chemical and biological preservatives.
12. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for meat, poultry and fish.
13. Meat tenderization.
14. Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH).
15. Meat quality parameters – color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions.
16. Meat cutting and handling.
17. Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation.
18. Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation.
19. Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation.

20. Surimi process, traditional and modern surimi production lines.
21. Quality of surimi products, comparison of surimi and fish mince products.
22. Problems on mass balancing of ingredients in formulation of value-added meat products.
23. Abattoir design and layout.
24. Preservation of fresh fish.
25. Characteristic of fresh fish and fermented and value-added products of fish.
26. Spoilage indices of fish and factors affecting the spoilage of fish.
27. Eggs: Structure, composition, quality characteristics.
28. Defects and grading of egg processing, preservation of eggs.
29. Processing and preservation of poultry meat and chicken patties.
30. Preparation protocols of indigenous products.
31. Fish sauce and paste.
32. By-products of meat, poultry, fish and eggs and their utilization.
33. Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI.
34. Kosher/Halal, EU hygienic regulations and ISO 9000 standards.

Practical Schedule

1. Pre-slaughter operations of meat animals and poultry birds.
2. Slaughtering and dressing of meat animals.
3. Study of post-mortem changes, Meat cutting and handling.
4. Preservation of meat by freezing, curing, pickling, dehydration.
5. Evaluation of quality and grading of eggs and preservation of shell eggs.
6. Preparation of value-added poultry meat products.
7. Study of anatomy and dressing of fish, Identification of different types of fish and quality evaluation of fish.
8. Preparation of sun-dried, salt cured fish, fish sauce.
9. Chilling and freezing of fish.
10. Preparations of fish protein concentrate, fish meal, marine fish oils and various fish products.
11. Preservation of fish by drying, pickling using fermentation process.
12. Preparation of value-added sea products: Cutlets, bullets, wafers.
13. Processing of fish oils; Canning methods for marine fishery products.
14. Estimation of TVB and TMA.
15. Determination of iodine value.
16. Visit to abattoir and fish and prawn processing industry.
17. Practical Examination.

Suggested Reading

1. Berkel, B. M.-V., Boogaard, B.V.-D. andHeijnen, C. 2004. Preservation of Fish and Meat.Agromisa Foundation, Wageningen.
2. Borstorm, G. 1961. Fish as Food - Vol. I, II, III and IV. Academic Press, New York.
3. FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.
4. Hall, G.M. 1997. Fish Processing Technology, 2nd edn. Chapman and Hall, London, UK.
5. Kerry, J., Kerry, J. and Ledward, D. 2005. Meat Processing-Improving Quality. Woodhead

Publishing Ltd., Cambridge, England.
6. Lawrie, R.A. 1985. Meat Science, 4th edn. Pergamon Press, Oxford, UK.
7. Nanda, Vikas 2014. Meat, Egg and Poultry Science and Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
8. Rautenstrauss, B.W. and Liehr, T. 2002. Fish Technology. Springer-Verlag, US.
9. Sen, D.P. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.
10. Sharma, B.D. and Sharma, K. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
11. Sharma, B.D. 2003. Modern Abattoir Practices and Animal Byproducts Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
12. Stadelman, W.J. and Cotterill, O.J. 1995. Egg Science and Technology, 4th edn. Food Products Press, NY, USA.
13. Swatland, H.J. 2004. Meat Cuts and Muscle Foods, 2nd edn. Nottingham Univ. Press, Nottingham.
14. Toldra, F., Hui, Y. H., Astiasaran, I., Nip, W.-K., Sebranek, J.G, Silveira, E.-T.F., Stahnke, L.H., Talon, R. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
15. Varnam, A.H. and Sutherland, J.P. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman and Hall, London.

FPT 3209 Processing Technology of Beverages 3 (2+1)

Objectives

1. Learn different about types of beverages.
2. Various technologies involved in beverage processing.
3. Gain knowledge about FSSAI specifications of beverages.
4. Understand ingredients, manufacturing and packaging processes for beverages.

Theory

Module I **(10 Hours)**

History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice-based beverages, synthetic beverages, still, carbonated; Low-calorie and dry beverages.

Module I **(15 Hours)**

Isotonic and sports drinks. Dairy based beverages, Alcoholic beverages, fruit beverages, specialty beverages, Tea, coffee, cocoa, spices, plant extracts, etc. FSSAI specifications for beverages. Ingredients, manufacturing and packaging processes and equipment for different beverages.

Module III **(4 Hours)**

Water treatment and quality of process water; Sweeteners, colorants, acidulants, Clouding and clarifying and flavouring agents for beverages.

Module IV **(5 Hours)**

Carbon dioxide and carbonation; Quality tests and control in beverages; miscellaneous beverages: Coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups.

Practical

Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant.

Lecture schedule

1. History and status of beverage industry in the world.
2. Significance and effect of beverages in health.
3. Classification of beverages.
4. Processing of beverages- packaging- filling.
5. Processing of packaged drinking water.
6. Preparation of juice-based beverages- RTS, squash.
7. Preparation of juice-based beverages- cordial and nectar.
8. Preparation synthetic beverages, still and carbonated beverages.
9. Importance and production of low-calorie and dry beverages.
10. Role and processing of isotonic and sports drinks.
11. Dairy based beverages- importance, nutritive value, health benefits.
12. Preparation of alcoholic beverages- wine, beer.
13. Preparation of distilled beverages-brandy, whisky.
14. Fruit beverages-methods-significance in health.
15. Specialty beverages- role-preparation.
16. Tea-plucking methods-tea processing.
17. Tea types- black, green, oolong, yellow-processing methods.
18. Coffee- varieties-nutrition-harvesting methods.
19. Processing of coffee-changes in composition.
20. Brewing of coffee- decaffeination and instant coffee preparation.
21. Cocoa- varieties-harvesting methods-processing-equipment.
22. Chocolate processing-types of chocolate products.
23. Spices and plant extracts- involved in beverages.
24. FSSAI specifications for beverages.
25. Ingredients, manufacturing and packaging processes and equipment for different beverages.
26. Water treatment and quality of process water.
27. Role and type of sweeteners, colorants.
28. Role and type of acidulants used in beverage industry.
29. Role of clouding and clarifying and flavouring agents for beverages.
30. Carbon dioxide and carbonation- methods-equipment.

31. Quality tests and control in beverages.
32. Miscellaneous beverages: nutritional benefits.
33. Miscellaneous beverages involved: coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups.
34. Threshold limits of ingredients in beverage foods.

Practical Schedule

1. Quality analysis of raw water.
2. Determination of density and viscosity of caramel.
3. Determination of colours in soft drinks by wool technique.
4. Preparation of iced tea.
5. Preparation of flavoured tea.
6. Preparation of carbonated beverages.
7. Preparation of non-carbonated beverage-wine.
8. Preparation of non-carbonated beverage-mead.
9. Determination of caffeine in beverages.
10. Determination of brix value and gas content.
11. Determination of acidity of beverages.
12. Determination of pH and acidity of beverages.
13. Quality analysis of tea and coffee;
14. Preparation of miscellaneous beverages.
15. Visit to carbonation unit.
16. Visit to mineral water plant.
17. Practical Examination.

Suggested Reading

1. Ashurst, P.R. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd edn. Blackwell Publishing Ltd., Oxford, UK.
2. Chakraverty, A., Mujumdar, A.S., VijayaRaghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc.,NY, USA.
3. Eblinger, H.M. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim. Germany.
4. Hui, Y.H. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Joshi, V.K. and Pandey, A. 1999. Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology, Vol. II. Educational Publishers and Distributors, New Delhi.
6. Varnam, A.H. and Sutherland, J.P. 1994. Beverages: Technology, Chemistry and Microbiology. Chapman, London, UK.

FPT 3210 Bakery, Confectionery and Snack Products 3 (2+1)

Objectives

1. Learn the processing, packaging and storage of bakery and confectionary products.
2. Understand extrusion technology and its application in production of breakfast cereals and snacks.

Theory

Module I **(7 Hours)**

Bakery products-Types (leavened and unleavened), specifications, compositions and ingredients (flour, sugar, fat, shortening, leavening agent etc.); Formulations, processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), equipment, packaging, storage and quality testing of bakery products.

Module II **(10 Hours)**

Processing technology of bread, biscuits and cakes. Classification of biscuits and manufacturing process of crackers; Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations; Hard boiled candies, pan coating, toffees and caramels, chewing gum and sugar-free confections; Processing of chocolate-types cocoa beans and processing, other ingredients, mixing, refining, conching, storage and packaging.

Module III **(7 Hours)**

Processing, equipment, packaging, storage and quality testing of confectionery and chocolate products. Product quality characteristics; Defects, causes and corrective measures. Extrusion technology and applications in food processing; Snack foods: Types, specifications, compositions, ingredients, Formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings.

Module IV **(10 Hours)**

Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients; Formulations, processing, equipment for breakfast cereals, macaroni and malts; Packaging, storage and quality testing for breakfast cereals, macaroni and malts. Cooked corn products-tortilla chips; Modified starches for snack foods; Oils and industrial frying. Preservatives used in Bakery, Confectionery and snack products preservation; Quality testing of Bakery, Confectionery and snack products.

Practical

Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items; preparation, packaging and quality evaluation of selected chocolates; Preparation of traditional Indian confection. Visit to bakery, confectionary and snack industry.

Lecture Schedule

1. Introduction and scope of baking and confectionery industry in India and world.
2. Bakery products-Types-leavened and unleavened-specifications.
3. Compositions, ingredients and their role in bakery products.
4. Formulations, processing of bakery products.
5. Equipment used in processing of bakery products.
6. Packaging, storage and quality testing of bakery products.
7. Processing technology of bread.
8. Processing technology of cakes.
9. Processing technology of biscuits.
10. Classification of biscuits and manufacturing process of crackers.
11. Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations.
12. Hard boiled candies, pan coating.
13. Toffees and caramels.
14. Chewing gum and sugar free confections.
15. Types of cocoa beans and processing.
16. Processing of chocolate-ingredients, mixing, refining, conching, storage and packaging.
17. Processing, packaging, storage of confectionery and chocolate products.
18. Equipment used in confectionery and chocolate products.
19. Quality testing of confectionery and chocolate products.
20. Product quality characteristics of confectionery and chocolate products; Defects, causes and corrective measures.
21. Extrusion technology and applications in food processing
22. Snack foods: Types, specifications, compositions, ingredients
23. Formulations, processing, equipment, packaging, storage and quality testing of Snack foods.
24. Snack food seasonings.
25. Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients.
26. Formulations, processing of breakfast cereals, macaroni and malts.
27. Equipment used for breakfast cereals, macaroni and malts.
28. Packaging, storage and quality testing for breakfast cereals, macaroni and malts.
29. Cooked corn products–tortilla chips.
30. Modified starches for snack foods.
31. Oils and industrial frying.
32. Preservatives used in Bakery.
33. Confectionery and snack products preservation.
34. Quality testing of Bakery, Confectionery and snack products.

Practical Schedule

1. Identifications and composition of various ingredients for snacks and bakery products.
2. Identifications and composition of various ingredients for confectionery products.
3. Study on flours and their classifications and characterization.

4. Analysis of gluten content in the flour.
5. Analysis of water absorption capacity of the flour.
6. Estimate the dough raising capacity of the flour.
7. Analyze the pH and acidity in the given flour.
8. Preparation, packaging and quality evaluation of selected snack items.
9. Preparation, packaging of selected bakery items.
10. Quality evaluation of selected bakery items.
11. Preparation, packaging of selected confectionery items.
12. Quality evaluation of selected confectionery items.
13. Preparation, packaging and quality evaluation of selected chocolates.
14. Preparation of traditional Indian confection.
15. Visit to bakery.
16. Visit to confectionary and snack units (industry).
17. Practical examination.

Suggested Reading

1. Amendola, J. and Rees, N. 2003. Understanding Baking: The Art and Science of Baking. 3rd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
2. Corke, H., Leyn, I. D., Cross, N. A. Nip, W. K., and Hui, Y. H. 2006. Bakery Products: Science and Technology, Blackwell Publishing Ltd., Oxford, UK.
3. Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd edn. Woodhead Publishing Limited, Cambridge, England.
4. Grewling, P. P. 2013. Chocolates and Confections, 2nd edn. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Hui, Y. H. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
6. Jackson, E. B. 1995. Sugar Confectionery Manufacture, 2nd edn. Springer-Verlag, US.
7. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
8. Kingslee, J.J. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
9. Matz, S.A. 1976. Snack Food Technology, 2nd edn. AVI Publishing Co., Inc., Westport, Connecticut, USA.
10. Minife, B.W. 1989. Chocolate, Cocoa, and Confectionary – Science and Technology, 3rd edn. Chapman and Hall, Inc., New York, USA.
11. Pyler, E.J. and Gorton, L.A. 2009. Baking Science and Technology, Vol. II: Formulation and Production, 4th edn. Sosland Publishing Company, Kansas City, MO, USA.
12. Pyler, E.J. and Gorton, L.A. 2008. Baking Science and Technology, Vol. I: Fundamentals and Ingredients, 4th edn. Sosland Publishing Company, Kansas City, MO, USA.

FPT 3211 Processing Technology of Liquid Milk 2(1+1)

Objectives

1. Understand different steps of milk processing.
2. Gain knowledge about different types of milk and their process.

Theory

Module I **(4 Hours)**

Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavoured milk.

Module II **(5 Hours)**

Effect of thermal treatment on milk constituents. Fermented milk, acidophilous milk, etc.; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting these changes and effects of these changes on the quality of finished products.

Module III **(3 Hours)**

Cream: definition, classification, manufacture of different types of cream, processing of cream; Adulterations in milk and its detection; Quality defects in milk - causes and prevention.

Module IV **(5 Hours)**

Liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical

Platform tests of raw milk (clot on boiling (COB) test, alcohol test); Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk; Packaging of liquid milk; Preparation of curd and yogurt, Visit to chilling centre and dairy plant.

Lecture Schedule

1. Dairy introduction- Historical development in India, Production and utilization of milk.
2. Composition of milk, Properties of milk.
3. Liquid milk collection, preservation, processing, packaging and storage.
4. Standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined

milk, flavored milk.

5. Effect of thermal treatment on milk constituents; Fermented milk, acidophilous milk etc.
6. Fermented milk products: Processing, Manufacture, storage and packaging of acidophilus milk.
7. Fermented milk products: Processing, Manufacture, storage and packaging of cultured buttermilk and other fermented milk.
8. Bio-chemical changes occurring during manufacture of fermented milks.
9. Factors affecting these changes and effects of these changes on the quality of finished products.
10. Cream: definition, classification, manufacture of different types of cream, processing of cream.
11. Adulterations in milk, Detection of adulteration in milk.
12. Quality defects in milk - causes and prevention.
13. Liquid milk collection, processing packaging and storage systems and equipment.
14. Bulk milk coolers, Milk chilling units, Milk reception equipment, Milk tanks/silos.
15. Pasteurizers, sterilizers, Centrifuges, clarifiers, filtration units.
16. Homogenizers, packaging and filling machines.
17. CIP units, Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical Schedule

1. Platform tests of raw milk {clot on boiling (COB) test}.
2. Platform tests of raw milk (alcohol test).
3. Determination of physical properties of milk.
4. Determination of proximate composition.
5. Study on biochemical properties of milk.
6. Determination of microbiological properties of milk.
7. Detection of adulterants in milk.
8. Identification and demonstration of liquid milk processing equipment-pipes-fittings.
9. Preparing standardized milk as per requirement.
10. Separation of fat from milk.
11. Study of Pasteurization of milk.
12. Homogenization of milk.
13. Packaging of liquid milk.
14. Preparation of curd.
15. Preparation of yogurt.
16. Visit to chilling center and dairy plant.
17. Practical examination.

Suggested Reading

1. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
2. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising

(F.R. Germany).
5. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
6. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.

Semester VII

S. No.	Course title	Credit Hours
1.	FPE 4110 Food Process Equipment Design	3 (2+1)
2.	FPT 4112 Processing Technology of Dairy Products	3 (2+1)
3.	BES 4126 ICT Applications in Food Industry	3 (1+2)
4.	FSE 4101 Seminar	1 (0+1)
5.	Elective Courses	10
Total		**20**

FPE 4110 Food Process Equipment Design 3(2+1)

Objectives

1. Learn design consideration for storage vessels, evaporators, crystallizers, separators etc.
2. Knowledge of safety aspects in equipment design.

Theory

Module I **(8 Hours)**

Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations. Design of pressure and storage vessels: Operating conditions, design conditions and stress.

Module II **(7 Hours)**

Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator. Design of agitators and separators: Design of agitators and baffles.

Module III **(11 Hours)**

Design of agitation system components and drive for agitation. Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. Design of freezing equipment: Design of ice-ream freezers and refrigerated display system. Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer.

Module IV **(8 Hours)**

Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin-screw extruder. Design of fermenters: Design of fermenter vessel, design problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

Practical

Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

Lecture Schedule

1. Introduction to food process equipment designs and classification of mechanical properties, ductility, hardness and materials for fabrication.
2. Corrosion, corrosion prevention methods for equipment, protective coatings materials.
3. Material codes: definition, classification, different types.
4. Stresses created due to static, dynamic loads and combined stresses, design stresses.
5. Design stresses, and theories of failure.
6. Safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations.
7. Design of pressure vessels.
8. Design of storage tanks.
9. Design of shell and its component.
10. Definition, types and design of heat exchangers.
11. Evaporating definition, types design of evaporators.
12. Design of single effect and multiple effect evaporators.
13. Design of rising film and falling film evaporators.
14. Definition, types and design of crystallizer.
15. Definition, types and design of agitators and separators.
16. Definition, types and design of centrifugal separators.
17. Considerations for optimization of design of various equipment.
18. Design of equipment components such as shafts, pulleys.
19. Design of equipment components such as bearings, belts.
20. Design of equipment components such as springs, drives, speed reduction systems.

21. Freezing, definition, methods.
22. Design of freezers.
23. Definition, types of dryers and design of dryers.
24. Design of tray dryer, tunnel dryer and fluidized bed dryer.
25. Design of tray dryer, tunnel dryer and fluidized bed dryer.
26. Design of spray dryer, vacuum dryer and microwave dryer.
27. Definition, types, methods of extrusion.
28. Cold and hot extruder design.
29. Design of single and twin-screw extruder.
30. Definition and types of fermenters.
31. Design of fermenter vessel.
32. Fermenters- design problems.
33. Introduction, definition, types of hazards and safety considerations.
34. Analysis of hazards and safety measures in equipment design, pressure relief devices.

Practical Schedule

1. Design of pressure vessel.
2. Design of heat exchangers.
3. Design of sterilizers and retort.
4. Design of single effect and multiple effect evaporators.
5. Design of rising film and falling film evaporators.
6. Numerical approach on design of evaporators.
7. Design of crystallizers.
8. Design of tray dryers; Design of spray dryer.
9. Numerical approach of design of dryers.
10. Design of freezers – numerical approach.
11. Design of separators.
12. Design of conveyors-Belt conveyors.
13. Design of conveyors- Screw conveyor.
14. Design of conveyors- Bucket elevators.
15. Design of twin-screw extruder.
16. Design of fermenters.
17. Practical Examination.

Suggested Reading

1. Albert Ibarz and Gustavo V. Barbosa-Canovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
2. Bhattacharyya, B. C. 2008. Introduction to Chemical Equipment Design- Mechanical Aspect. CBS Publishers and Distributors, New Delhi.
3. Couper, J.R., Penney, W.R., Fair, J.R. and Walas, S.M. 2012 Chemical Process Equipment: Selection and Design. Elsevier Inc.
4. Geankoplis, C. J. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.

5. Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
6. Richardson, J F. and Peacock, D.G. 1994. Coulson and Richardsons's Chemical Engineering, Vol. 3, Chemical and Biochemical Reactors and Process Control, 3rd edn. Elsevier Butterworth- Heinemann, Amsterdam, The Netherlands.
7. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.
8. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
9. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
10. Stanbury, P.F. Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.
11. Valentas, K.J., Rotstein, E. and Singh, R.P. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

FPT 4112 Processing Technology of Dairy Products 3(2+1)

Objectives

1. Learn the processing of dairy products viz. cream, butter, ghee, ice-cream etc.
2. Gain knowledge of traditional dairy products and their processing.

Theory

Module I **(8 Hours)**

Cream: Basic aspect, Classification, manufacture of different types of cream, processing of cream; Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter-defects, causes and their prevention, packaging and storage; Butter oil and ghee: Definition, composition, processing, equipment, quality tests

Module II **(8 Hours)**

Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage. Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram, equipment, quality testing, defects, causes and prevention, packaging and storage.

Module III **(8 Hours)**

Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk. Manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage.

Module IV **(10 Hours)**

Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.

Practical

Preparation of butter/ table butter, Preparation of ghee, Preparation of paneer; Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts; Preparation of condensed milk; Preparation of spray dried milk powder; Preparation of selected Indian dairy products; Shrikhand, Mawa/khoa-based products halwa/ kheer etc., Determination of selected quality parameters of selected dairy products; Visit to dairy plant.

Lecture Schedule

1. Cream: Basic aspect, classification.
2. Manufacture of different types of cream, processing of cream.
3. Classification of dairy products.
4. Butter: Definition, composition.
5. Processing and production steps.
6. Overrun in butter, butter making machines.
7. Quality testing of table butter, butter- defects, causes and their prevention, packaging and storage.
8. Butter oil and ghee: Definition, composition, processing, equipment.
9. Quality tests of butter oil and ghee.
10. Paneer: Definition, composition, types, processing steps, process flow diagram.
11. Paneer: equipment, quality defects, causes and prevention, packaging and storage.
12. Cheese: Definition, composition, types, processing steps, process flow diagram.
13. Cheese: equipment, quality defects, causes and prevention, packaging and storage.
14. Ice cream and frozen desserts: Definition, composition.
15. Ice cream and frozen desserts: types.
16. Processing steps and flow diagram.
17. Equipment, quality testing, defects causes and prevention, packaging and storage.
18. Condensed milk: Definition, composition.
19. Dried milk: Definition, composition.
20. Role of milk constituents in condensed milk.
21. Manufacture of condensed milk.
22. Types of standards for dried milk.
23. Manufacture of SMP and WMP using roller and spray drying.
24. Instantization, and recent developments in drying.
25. Quality testing, defects, causes and prevention, packaging and storage.
26. Traditional Indian Dairy Products (Khoa based); Dhap, Pindi, and Dhanedar: Definitions, compositions, processing, packaging, storage.
27. Equipment and quality testing of Khoa based products.
28. Traditional Indian Dairy Products (Khoa based); Peda, Burfi, Kalakand, Milk cake, Gulab jamun: Definitions, compositions, processing, packaging, storage.

29. Traditional Indian Dairy Products (Others); Rabri, Basundi: Definitions, compositions, processing, packaging, storage.
30. Traditional Indian Dairy Products (Others); Kheer/Payasm, Dried Kheer mix: Definitions, compositions, processing, packaging, storage.
31. Traditional Indian Dairy Products (Others); Channa and channa based sweet (Rasagolla): Definitions, compositions, processing, packaging, storage.
32. Traditional Indian Dairy Products (Fermented types); Dahi, Misti Dahi, Buttermilk, Lassi: Definitions, compositions, processing, packaging, storage.
33. Traditional Indian Dairy Products (Fermented types); Chakka, Shrikhand, Kadhi, Raita, Dahiwada, Rabadi: Definitions, compositions, processing, packaging, storage.
34. By- products of dairy industry and their utilization.

Practical Schedule

1. Preparation of butter.
2. Preparation of table butter.
3. Preparation of ghee.
4. Preparation of paneer.
5. Preparation of selected type of cheese.
6. Preparation of selected type of cheese.
7. Preparation of ice-cream.
8. Preparation selected frozen desserts.
9. Preparation selected frozen desserts.
10. Preparation of condensed milk.
11. Preparation of milk powder.
12. Preparation selected Indian dairy products.
13. Preparation selected Indian dairy products.
14. Preparation of selected Indian dairy products.
15. Determination of selected quality parameters of selected dairy products.
16. Visit to dairy plant.
17. Practical examination.

Suggested Reading

1. Products: Handbook of Process Technology Modernization for Professionals Entrepreneurs and Scientists, Dairy India Yearbook.
2. De, S. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
3. Kanekanian, A. 2014. Milk and Dairy Products as Functional Foods. John Wiley and Sons, Ltd., UK.
4. Kessler, H.G. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising, F.R. Germany.
5. Hui, Y.H. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
6. Walstra, P., Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology, 2nd edn. CRC Press, Boca Raton, FL, USA.

7. Tamime, A. Y. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.

BES 4126 ICT Applications in Food Industry 3(1+2)

Objectives

1. Understand the requirement of information and its computerization and SCADA systems.
2. Learn different software tools like MATLAB, GAMBIT, Fluent, LabVIEW etc.
3. Learn different techniques like Fuzzy logic, Neural network, Image processing etc.

Theory

Module I **(5 Hours)**

Importance of computerization in food industry, operating environments and information systems for various types of food industries. Introduction to Supervisory control and data acquisition (SCADA): SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems. Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems. Use of add-ins, use of solver. Web hosting and webpage design; file transfer protocol (FTP), Online food process control from centralized server system in processing plant.

Module II **(5 Hours)**

Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system. Problem solving methodologies, numeric, cell, arrays, matrix operations; User defined functions, programming using MATLAB; debugging MATLAB programs, Applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB; Function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to Toolboxes useful to Food Industry, Curve fitting toolbox, Fuzzy logic toolbox, Neural Network tool box, Image processing tool box, statistical toolbox.

Module III **(4 Hours)**

Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry; Introduction to CFD software, GAMBIT and Fluent software.

Module IV **(4 Hours)**

LabVIEW – LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in Lab VIEW; Lab VIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select

(if statement) ,file I/O; Lab VIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.

Practical

Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.

Lecture Schedule

1. Importance of computerization in food industry – scope and introduction to software package operating environments and information systems for various types of food industries.
2. Supervisory control and data acquisition (SCADA) - application in food processing industries, SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems.
3. Spreadsheet applications -Data interpretation and solving problems, data interpretation techniques, Preparation of charts, use of macros to solve engineering problems.
4. Overview on use of add-ins, use of solver – its application in solving problems.
5. Web hosting and webpage design- software involved in web designing and it application, On-line food process control from centralized server system in processing plant - file transfer protocol (FTP).
6. Use of MATLAB in food industry – introduction on MATLAB and its components, Computing with MATLAB, script files and editor/debugger, MATLAB help system, problem solving methodologies, numeric, cell, arrays, matrix operations.
7. MATLAB user defined functions, programming using MATLAB - Debugging
8. MATLAB programs, applications to simulation – solving equations in MATLAB.
9. Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, Interactive plotting in MATLAB, function discovery, regression, the basic fitting interface, three dimensional plots.
10. Introduction to toolboxes useful to food industry, curve fitting toolbox- Fuzzy logic toolbox, Neural network toolbox, image processing toolbox, statistical toolbox its application in solving problems.
11. Introduction to computational fluid dynamics (CFD), application of CFD in food processing, Governing equations of fluid dynamics, application to solve heat transfer equation.

12. Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations.
13. Physical boundary conditions, discretization, using suitable heat and mass transfer condition.
14. Applications of CFD in food and beverage industry- applications to simulation - solving equations in CFD software, Introduction to CFD software, GAMBIT and FLUENT software- applications food industries.
15. Lab VIEW – Lab VIEW environment -Getting data into computer, data acquisition devices, NI-DAQ, Lab VIEW – simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette, Components of a LabVIEW application-LabVIEW environment -Creating a VI, data Flow execution.
16. LabVIEW application-debugging techniques, additional help, context help, tips for working in LabVIEW, LabVIEW typical program - Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette.
17. Creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O.
18. LabVIEW results- Displaying data on front panel, controls and indicators, graphs, LabVIEW results-charts, arrays, loop timing, signal processing, textual math, math script.

Practical Schedule

1. Introduction to various features in spreadsheet, editing, formatting, arithmetic operations.
2. Solving problems using functions in spreadsheets.
3. Spreadsheet charts- plotting Graphs- scatter, Line, Bar, Column, Pie, 2D and 3D charts.
4. Use of Add-Ins in spreadsheet and statistical data analysis using Analysis Tool pack.
5. Solution of problems on regression analysis using Analysis Tool pack in spreadsheet.
6. Solution of problems on optimization using solver package in a spreadsheet.
7. Use of macros to solve engineering problems.
8. Small case study with Food data analysis.
9. Overview to MATLAB and its components, Computing with MATLAB, script files and editor/debugger, MATLAB help system.
10. MATLAB numeric, cell, arrays, matrix operations.
11. MATLAB Programming – input/output statements-scripts for numerical and matrix calculations.
12. MATLAB Programming – programs for solving simple problems related to food industry – branching, looping statements.
13. MATLAB user defined functions, programming using MATLAB - Debugging MATLAB.
14. Problem solving with MATLAB – programs for solving simple problems related to food industry.
15. Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots.
16. MATLAB special plot types, Interactive plotting in MATLAB, function discovery, regression, the basic fitting interface, three-dimensional plots.
17. Solution of problems using Curve Fitting Toolbox in MATLAB.
18. Solution of problems using Fuzzy Logic Toolbox in MATLAB.

19. Solution of problems using Neural Network Toolbox in MATLAB.
20. Solution of problems using Image Processing Toolbox in MATLAB.
21. Solution of problems using Statistical Toolbox in MATLAB.
22. Overview to GAMBIT software.
23. Creation of geometry for laminar flow through pipe using GAMBIT.
24. Overview to FLUENT software -solving equations in CFD software.
25. Import of geometry and application of boundary conditions.
26. Import of geometry and application of boundary conditions.
27. Solution of problems on laminar flow using FLUENT.
28. Solution of problems on laminar flow using FLUENT.
29. Solution of problems on laminar flow using FLUENT.
30. Overview to LabVIEW and NI-DAQ.
31. LabVIEW environment -Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition.
32. LabVIEW- Creating a VI, data Flow execution.
33. LabVIEW– creating functions and sub VIs, types of functions, function palette.

Suggested Reading

1. Bailey, D. and Wright, E. 2003. Practical SCADA for Industry. Elsevier, Burlington, MA.
2. Chapman, N. and Chapman, J. 2006. Web Design: A Complete Introduction. John Wiley and Sons, USA.
3. National Instruments Corporation. 2005. Introduction to LabVIEW: 3-Hour Hands-On. NI, Austin, Texas.
4. Palm III, W. J. 2011. Introduction to MATLAB for Engineers, 3rd edn. McGraw-Hill Companies, Inc., NY, USA.
5. Singh, R.P. 2014. Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis. Academic Press, London.
6. Sun, D. W. 2007. Computational Fluid Dynamics in Food Processing. CRC Press, Boca Raton, FL, USA.

Elective Courses

S. No.	Course Title	Credit Hours
1.	EFT 4101 Design and Formulation of Foods	3 (2+1)
2.	EFS 4101 Industrial Microbiology	3 (2+1)
3.	EFS 4102 Introduction to Food Biotechnology	3 (2+1)
4.	EBE 4108 Business Management and Economics	2 (2+0)
5.	EBE 4109 Statistical Methods and Numerical Analysis	2 (1+1)
6.	EBE 4110 Instrumentation and Process Control in Food Industry	3 (1+2)
7.	EFS 4103 Instrumental Techniques in Food Analysis	3 (2+1)
8.	EFT 4102 Traditional Indian Dairy Products	2 (1+1)
9.	EFT 4103 Ice-Cream and Frozen Desserts	3 (2+1)

10.	ERE 4104 Energy Conservation and Management	2 (1+1)
11.	ERE 4105 Applications of Renewable Energy in Food Processing	2 (1+1)
12.	EFE 4101 Food Plant Design and Layout	3 (2+1)
13.	EFE 4102 Waste and By-Products Utilization	3 (2+1)

EFT 4101 Design and Formulation of Foods 3 (2+1)

Objectives

1. Understand about RDA for Indians.
2. Design and formulate new and innovative target foods.
3. Gain knowledge about various therapeutic diets.

Theory

Module I **(8 Hours)**

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups.

Module II **(10 Hours)**

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.

Module III **(6 Hours)**

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.

Module IV **(10 Hours)**

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 probiotic 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.

Lecture Schedule

1. Introduction to nutrients and their function.
2. Macronutrients and their functions.
3. Micronutrients (vitamins) and their function.
4. Micronutrients (minerals) and their function.
5. Food classification and their nutritive value.
6. Anti-nutritional factors present in food.
7. Concept of different food groups.
8. Recommended dietary allowances (RDA) for Indians.
9. Nutrition and RDA for infant.
10. Nutrition and RDA for pre-school.
11. Nutrition and RDA for schoolchildren.
12. Nutrition and RDA for Adolescence.
13. Nutrition and RDA for Adult.
14. Nutrition and RDA for Pregnant women.
15. Nutrition and RDA for lactating women.
16. Nutrition and RDA for old age people.
17. Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value-addition.
18. Therapeutic diets–Principles and objectives of diet therapy.
19. Diet for patient suffering from Diabetes mellitus.
20. Diet for patient suffering from osteoporosis.
21. Diet for patient suffering from cardiac problem.
22. Diet for patient suffering from gastrointestinal disorder.
23. Diet planning.
24. Use of exchange list in nutrient calculation.
25. Functional foods - definition and concepts.
26. Design of functional foods.
27. Nutraceuticals food - definition and concepts.
28. Design of nutraceutical foods.
29. Recent trends in food formulation.
30. Antioxidant rich food products.
31. Concepts for formulation of foods for drought and disaster afflicted.
32. Concepts for formulation of foods for defence services.
33. Concepts for formulation of foods for sportsmen.
34. Concepts for formulation of foods for space food.

Practical Schedule

1. Study on principles of planning menu.
2. Develop diet plan using food exchange list and nutrient calculation for school children.
3. Develop diet plan using food exchange list and nutrient calculation for adult.
4. Develop diet plan using food exchange list and nutrient calculation for pregnant women.
5. Preparation and formulation of Indian Traditional Snack.

6. Preparation and formulation of Indian Traditional Sweet.
7. Preparation and development of food for pregnant women.
8. Preparation and development of food for lactating women.
9. Preparation and development of food for foods for infants.
10. Preparation and formulation of food and energy drinks for diabetic person (sugar-free food products).
11. Preparation and formulation of food and energy drinks for sportsperson and osteoporosis.
12. Preparation of prebiotic and probiotic food product.
13. Preparation of functional food using millets.
14. Preparation of functional whey beverage probiotic beverage.
15. Production of functional beverage and antioxidant determination.
16. Visit to Food Processing Industries/Expos.
17. Practical examination.

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 and Hall, NY, USA.
6. Mazza, G.1998. Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson, C. 1975. Basic Nutrition and Diet Therapy, Macmillan.
8. Swaminathan, M.1974. Essentials of Nutrition, Ganesh Co.
9. Steinkrauss, K.H. 1995. Handbook of Indigenous Fermented Foods, Marcel Dekker.

EFS 4101 Industrial Microbiology 3(2+1)

Objectives

1. Learn about industrially important micro-organism and their growth.

2. Understand bioreactor design and downstream processing.

Theory

Module I **(12 Hours)**

Overview of Industrial Microbiology; Introduction to industrial fermentations, Range of fermentation processes, Chronological development, Compartmental part of fermentation processes; Industrially Important Microorganisms. Criteria for Selection of Industrially Important Microorganisms, Overview of strain improvement of Industrially Important Microorganisms, Preservation of industrially important microorganisms.

Module II **(8 Hours)**

Fermentation Media; Media selection, Medium Formulation, Medium for industrial fermentation; Microbial Growth; Typical Growth Curve, Synchronous growth, Batch Fermentations, Continuous Fermentation; Fed Batch Fermentation.

Module III **(7 Hours)**

Bioreactor Design: Basic functions, Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories, Types of reactor; Problems related to scale up of Process.

Module IV **(7 Hours)**

Upstream and Down Stream Processes: Upstream processes, Overview of Downstream Processing, Methods of cell destruction, Methods of purification of enzyme/product, Concentration and Packaging.

Practical

Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/ proteases/Lipase; Production and assay of Nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast Mushroom production.

Lecture Schedule

1. Overview of Industrial Microbiology.
2. Introduction to industrial fermentations.
3. Range of fermentation processes.
4. Chronological development of fermentation processes.
5. Compartmental part of fermentation processes.
6. Industrially Important Microorganisms.
7. Industrially Important Microorganisms.
8. Criteria for Selection of Industrially Important Microorganisms.
9. Overview of strain improvement of Industrially Important Microorganisms.
10. Overview of strain improvement of Industrially Important Microorganisms.
11. Preservation of industrially important microorganisms.
12. Preservation of industrially important microorganisms.
13. Fermentation Media.
14. Fermentation Media.
15. Media selection, Medium Formulation.
16. Medium for industrial fermentation.
17. Microbial Growth.
18. Typical Growth Curve.
19. Synchronous growth.

20. Batch Fermentations.
21. Continuous Fermentation.
22. Fed Batch Fermentation.
23. Bioreactor Design: Basic functions.
24. Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories.
25. Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories.
26. Types of reactor.
27. Types of reactor.
28. Problems related to scale up of Fermentation Process.
29. Upstream and Down Stream Processes: Upstream processes.
30. Upstream and Down Stream Processes: Overview of Downstream Processing.
31. Methods of cell destruction: Mechanical destruction methods.
32. Methods of cell destruction: Non-mechanical destruction methods.
33. Methods of purification of enzyme/product, Concentration and Packaging.
34. Methods of purification of enzyme/product, Concentration and Packaging.

Practical Schedule

1. Isolation and screening of citric acid/ amylase/protease/antibiotics producing microbes.
2. Production of citric acid.
3. Production of Lactic acid.
4. Production of Acetic acid.
5. Purification of citric acid/Lactic acid/ Acetic acid.
6. Estimation of citric acid/Lactic acid/ Acetic acid.
7. Standardization of physical factors for higher yields of citric acid.
8. Isolation, identification of cultures producing bio-colours.
9. Production of beer/ethanol.
10. Purification and estimation of beer/ethanol.
11. Production of fungal amylases/ proteases/Lipase.
12. Purification and assay of fungal amylases/ proteases/Lipase.
13. Production and assay of Nisin from lactic acid bacteria.
14. Production of Single cell protein.
15. Production of Starter culture of Baker's yeast.
16. Cultivation of Mushroom.
17. Practical examination.

Suggested Reading

1. Briggs, D.E., Boulton, C.A., Brookes, P.A. and Stevens, R. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
2. Casida Jr., L.E. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.
3. Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.

4. Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th edn. AVI Publishers, Connecticut, USA.
5. Stanbury, P.F., Whitakar, A. and Hall, S.J. 1995. Principles of Fermentation Technology, 2nd edn. Elsevier Science Ltd., Burlington, MA, USA.

EFS 4102 Introduction to Food Biotechnology 3(2+1)

Objectives

1. Understand various biotechnological terminology.
2. Understand application of biotechnology in food systems.

Theory

Module I **(7 Hours)**

Introduction, History and scope of biotechnology, Review of DNA replication, transcription, and translation. Natural and artificial mechanisms of DNA transfer.

Module II **(10 Hours)**

Introduction to vectors, Selectable markers, Cloning vectors, Expression vectors, Shuttle vectors, Creation of recombinant DNA molecules, Creation of genomicand cDNA libraries. Library screening, Ligation, Restriction endonuclease digestion and mapping, Gel electrophoresis, Northern blotting, Southern blotting.

Module III **(7 Hours)**

Polymerase Chain Reaction (PCR), DNA sequencing and sequence analysis, Reverse transcriptase PCR, Real time PCR, Production of monoclonal antibodies, Immunoblotting. DNA microarrays, Protein microarrays.

Module IV **(10 Hours)**

Introduction to bioinformatics. Applications of biotechnology: Genetically engineered foods, Bioremediation, DNAfingerprinting, Molecular diagnostics, Molecular forensics Transgenic organisms, Ethical issues inbiotechnology, The future of biotechnology.

Practical

Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization; Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from *E. Coli* and *Bacillus cereus*; Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by *Pseudomonas* spp.

Lecture Schedule

1. Introduction, history and scope of biotechnology.
2. Review of DNA replication.

3. Review of DNA replication.
4. Review of transcription.
5. Review of transcription.
6. Review of translation.
7. Review of translation.
8. Natural and artificial mechanisms of DNA transfer.
9. Introduction to vectors, selectable markers.
10. Cloning vectors.
11. expression vectors.
12. Shuttle vectors.
13. Creation of recombinant DNA molecules.
14. Creation of genomicand cDNA libraries.
15. Library screening, ligation.
16. Restriction endonuclease digestion and mapping.
17. Gel electrophoresis.
18. Northern blotting.
19. Southern blotting.
20. Polymerase chain reaction (PCR).
21. DNAsequencing and sequence analysis.
22. Reverse transcriptase PCR.
23. Production of monoclonal antibodies.
24. Immunoblotting.
25. DNA microarrays.
26. Protein microarrays.
27. Introduction to bioinformatics.
28. Applications of biotechnology: genetically engineered foods.
29. Bioremediation.
30. DNAfingerprinting.
31. Molecular diagnostics.
32. Molecular forensics transgenic organisms.
33. Ethical issues inbiotechnology.
34. The future of biotechnology.

Practical Schedule

1. Study of auxotroph.
2. Micro-propagation through tissue culture.
3. Micro-propagation through tissue culture.
4. Strain improvement through U.V. mutation for lactose utilization.
5. Chemical mutagenesis using chemical mutagens (Ethidium bromide).
6. Determination of survival curves using physical and chemical mutagens.
7. Isolation and analysis of chromosomal/genomic DNA from *E. Coli* and *Bacillus cereus.*
8. Isolation and analysis of chromosomal/genomic DNA from *E. Coli* and *Bacillus cereus.*
9. Separation of protoplastusing cellulytic enzymes.
10. Production of biomass from fruit and vegetable waste.

11. Introduction of ELISA.
12. Introduction of Southern blot.
13. Introduction of DNA finger printing.
14. Agarose gel electrophoresis of plasmid DNA.
15. Agarose gel electrophoresis of plasmid DNA.
16. Pesticide degradation by *Pseudomonas* spp.
17. Practical examination.

Suggested Reading

1. Brandenberg, Oliver, Dhlamini, Zephaniah, Sensi, Alessandra, Ghosh, Kakoli and Sonnino, Andrea. 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.
2. Paul, Meenakshi. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
3. Primrose, S.B. and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.
4. Renneberg, R. And Lorch, V. 2017. Biotechnology for Beginners. Academic Press.
5. Singh, B.D. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
6. Smith, J.E. 2009. Biotechnology, 5th edition, Cambridge University Press, Cambridge, UK.
7. Stahl, U., Donalies, U.E.B. and Nevoigt, E. 2009. Food Biotechnology. Springer Berlin, Heidelberg.
8. Watson, James D. 2013. Molecular Biology of the Gene, 7th edn. Benjamin Cummings, San Francisco, USA.

EBE 4108 Business Management and Economics 2(2+0)

Objectives

1. Learn basic principles of management.
2. Learn basic financial and human resource management.

Theory

Module I **(9 Hours)**

Definitions, management principles, scientific principles, and administrative principles. Maslow's Hierarchy of Needs theory. Functions of management: Planning, organizing, staffing, directing, and controlling. Organizational structures and principles of organization. Types of organization: Formal and informal, line, line and staff, matrix, and hybrid

Module II **(10 Hours)**

Introduction to economics: Definitions, nature, scope, and the difference between microeconomics and macroeconomics. Theory of demand and supply, elasticity of demand, price and income elasticity. Types of markets and their characteristics. National income: GDP, GNP, NNP, disposable personal income, per capita income, and inflation.

Module III **(12 Hours)**

Theory of production: Production function and factors of production. Law of variable proportions and the law of returns to scale. Cost: Short run and long run costs, fixed cost, variable cost, total cost, average cost, marginal cost, and opportunity cost. Break-even analysis. Finance management: Definition, scope, and objective. Different systems of accounting: Financial accounting, cost accounting, and management accounting.

Module IV **(3 Hours)**

Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, and process of selection. Corporate social responsibility: Importance and business ethics.

Lecture Schedule

1. Definitions of Management.
2. Management Principles.
3. Scientific Principles of Management.
4. Administrative Principles of Management.
5. Maslow's Hierarchy of Needs Theory.
6. Functions of Management.
7. Organizational Structures.
8. Principles of Organization.
9. Types of Organization.
10. Introduction to Economics: Definitions, Nature, and Scope.
11. Microeconomics vs. Macroeconomics.
12. Theory of Demand and Supply.
13. Elasticity of Demand.
14. Price Elasticity of Demand.
15. Income Elasticity of Demand.
16. Types of Markets and Characteristics.
17. National Income Concepts: GDP, GNP, NNP.
18. Disposable Personal Income and Per Capita Income.
19. Inflation: Causes and Effects.
20. Theory of Production: Production Function.
21. Factors of Production.
22. Law of Variable Proportions.
23. Law of Returns to Scale.
24. Cost Concepts: Short Run and Long Run Costs.
25. Fixed, Variable, Total, Average, and Marginal Costs.
26. Opportunity Cost.
27. Break-even Analysis.
28. Finance Management: Definition, Scope, and Objective.
29. Financial Accounting.
30. Cost Accounting, Management Accounting.
31. Human Resource Management: Definitions and Objectives.

32. Manpower Planning: Process and Importance.
33. Sources of Recruitment, Process of Selection.
34. Corporate Social Responsibility, Business Ethics.

Suggested Reading

1. Dewett, K.K. and Navalur, M.H. Modern Economic Theory. S. Chand and Sons, New Delhi.
2. Harold, K. Principles of Management. Tata McGraw-Hill Education Private Limited, NewDelhi.
3. Jain, S.P. Financial Accounting. Kalyani Publications, Ludhiana.
4. Prasad, L.M. 2001. Principles and Practices of Management, 9th edn. S. Chand and Sons, NewDelhi.
5. Rao, P. Subba. Human Resource Management. Himalaya Publications.
6. Thomas, P.C. Managerial Economics, 9th edn. Kalyani Publishers.

EBE 4109 Statistical Methods and Numerical Analysis 2(1+1)

Objectives

1. Learn different statistical test.
2. Understand design.

Theory

Module I **(6 Hours)**

Introduction to statistics: Descriptive Statistics (Measures of central tendency, Measures of dispersion), Statistical inference and testing of hypothesis-Introduction, level of significance, types of error, degrees of freedom, critical region, power of the test. Large sample test -Z test (Testing the mean of a population, testing the equality of two population means and population proportions), Small sample test- t-test (t-test for population mean, t-test for equality of two population means, paired t-test, t-test for the significance of correlation and regression coefficient), testing of significance through variance (F test). Chi-square test and its uses-testing the goodness of fit, test of independence (contingency table, 2x2 and mxn)

Module II **(4 Hours)**

Correlation analysis - Definition, properties, Methods of correlation (Spearman Rank correlation, Karl Pearson coefficient of correlation), partial and multiple correlation, Regression analysis - basic concepts, Curve fitting (OLS method), Linear and nonlinear regression.

Module III **(7 Hours)**

Analysis of Variance (ANOVA) – One-way ANOVA, Two-way ANOVA. Design of experiments: Basic principles of experimental design, Basic designs - (Layout and analysis) Completely Randomized design (CRD) with equal and unequal observations, Randomized Block Design (RBD), Latin Square Design (LSD), Factorial experiment, 2^2 factorial experiments, Response surface methodology.

Practical

Problems on Z test – One and two sample test Problems on t test - One and two sample (dependent and independent) test; Problems on F test, chi square test, correlation and regression; Fitting of simple linear regressions; Fitting of multiple regression equations; ANOVA: One way/ two way; 2^2; Problems on CRD, RBD, LSD, Problems on response surface methodology.

Lecture Schedule

1. Descriptive statistics (Measures of central tendency and dispersion).
2. Testing of hypothesis (introduction, level of significance, types of error, degree of freedom, critical region, power of the test).
3. Large sample test (Z test- test for the mean of population, test for the equality of two population mean and population proportion).
4. Small sample test (t-test for population mean, paired t-test, test for the significance of correlation and regression coefficient).
5. F test - Testing the significance through variance.
6. Chi-square test-Testing the goodness of fit.
7. Independence of attribute (contingency table).
8. Correlation analysis, Karl Pearson coefficient of correlation.
9. Spearman Rank correlation.
10. Partial and multiple correlation.
11. Regression analysis
12. Curve fitting.
13. One-way ANOVA and Two-way ANOVA.
14. CRD - layout and analysis, RBD - layout and analysis.
15. LSD -layout and analysis of mxm LSD.
16. Factorial experiment, 2^2 factorial experiment.
17. Response surface methodology.

Practical Schedule

1. Z test - Problems on one sample test.
2. Z test - Problems on two-sample test.
3. Z test - Problems on population proportion.
4. t-test - one sample test.
5. t-test - two sample test, paired t-test.
6. F test - test for the variance of population, equality of variance.
7. Chi-square test (test the goodness of fit, Independence of attribute).
8. Karl Pearson coefficient of correlation.
9. Spearman Rank correlation.
10. Curve fitting (regression equation, linear and non-linear).
11. One-way ANOVA.
12. Two-way ANOVA.
13. Completely Randomized design CRD.
14. RBD, LSD.

15. 2^2 factorial experiment.
16. Response surface methodology.
17. Practical Examination.

Suggested Reading

1. Agrawal, B.L.1991. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
2. Grewal, B.S. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
3. Grewal, B.S. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
4. Gupta S.C and Kapoor V.K, 1970. Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
5. Gupta, S.C and Kapoor V K. 2019 Fundamentals of Applied Statistics. Sulthan Chand &Sons
6. Kreyszig, E.2006.Advanced Engineering Mathematics, 9thedn. John Wiley and Sons, New York, USA
7. NageswaraRao, G, 2007.Statistics for Agricultural Science BS Publications.
8. Rangaswamy, R. 2018. A Text Book of Agricultural Statistics. New Age Int. Publications Ltd.

EFS 4103 Instrumental Techniques in Food Analysis 3(2+1)

Objectives

1. Learn various instruments used for food analysis.
2. Learn the methods of various analyses.
3. Gain knowledge about various equipment and their working for those analyses.

Theory

Module I **(7 hours)**

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.

Module II **(7 hours)**

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.

Module III **(15 hours)**

Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultra-centrifugation, Iso-electric focusing.

Module IV **(5 hours)**

Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, Rapid microbiological methods: Overview,

Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products; Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Quality evaluation of food products for color and taste of marketed products; Analysis of heavy metals using atomic absorption spectrophotometer; Estimation of phytic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of pralines by ion- exchange chromatography; Molecular weight determination using sephadox-gel; Identification of organic acids by paper electrophoresis; Gel- electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLC, GCMS; Quantitative make-up of water and fat soluble vitamins using HPLC; Fatty acid profiling using gas chromatograph; Separation of sugars by paper chromatography; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A and B).

Lecture Schedule

1. Concepts of food analysis.
2. Rules and regulations of food analysis.
3. Principles and methodology involved in analysis of foods.
4. Rheological analysis of food.
5. Textural profile analysis of foods.
6. Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis.
7. Adulterations.
8. Principles and methodology involved in analytical techniques: spectroscopy.
9. Principles and methodology involved in analytical techniques: ultraviolet-visible spectroscopy.
10. Principles and methodology involved in analytical techniques: infrared spectroscopy.
11. Principles and methodology involved in analytical techniques: atomic absorption and emission spectroscopy.
12. Principles and methodology involved in analytical techniques: flourescence spectroscopy.
13. Principles and methodology involved in analytical techniques: mass spectrometry.
14. Food compositional analysis and applications in the food industry.
15. Chromatography: Principle of chromatography.
16. Chromatography: classifications: Adsorption, column, partition method.
17. Chromatography: classification: gel-filtration method.
18. Chromatography: classification: affinity method.
19. Chromatography: classification: ion-exchange method.
20. Chromatography: classification: size-exclusion method.
21. Chromatography: gas-liquid chromatography.
22. Chromatography: High performance liquid chromatography.

23. Chromatography: Ion chromatography and others.
24. Separation techniques: Dialysis.
25. Separation techniques: electrophoresis.
26. Separation techniques: sedimentation.
27. Separation techniques: ultra-filtration.
28. Separation techniques: ultra-centrifugation.
29. Separation techniques: iso-electric focusing.
30. Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity.
31. Chemically sensitive semiconductor devices: amperometric, potentiometric and Acoustic sensors.
32. Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay.
33. Chemosensors, biosensors, immunosensors.
34. Chemosensors, biosensors, immunosensors.

Practical Schedule

1. Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products.
2. Quality evaluation of food products for color and taste of marketed products.
3. Analysis of heavy metals using atomic absorption spectrophotometer.
4. Estimation of phytic acid using spectrophotometer.
5. Separation of amino acids by two-dimensional paper chromatography.
6. Identification of sugars in fruit juice using TLC.
7. Separation of pralines by ion-exchange chromatography.
8. Molecular weight determination using sephadox-gel.
9. Identification of organic acids by paper electrophoresis.
10. Gel- electrophoresis for analytic techniques: DNA and protein.
11. Quantitative determination of sugars and fatty acid profile by GLC, GCMS.
12. Quantitative make-up of water and fat-soluble vitamins using HPLC.
13. Fatty acid profiling using gas chromatograph.
14. Separation of sugars by paper chromatography.
15. Analysis of foods for pesticide and drug residues.
16. Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A and B).
17. Practical examination.

Suggested Reading

1. Nieisen, S.S. 2010. Food Analysis Laboratory Manual, 2nd edn. Springer, NY, USA.
2. Nieisen, S.S. 2003. Food Analysis, 3rd edn. Kluwer Academic, New York, USA.
3. Ötles, S. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
4. Sun, D.W. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

EFT 4102 Traditional Indian Dairy Products 2 (1+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

Module I **(5 Hours)**

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.

Module II **(5 Hours)**

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.

Module III **(4 Hours)**

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. MistiDahi: Product description method of manufacture and packaging process.

Module IV **(3 Hours)**

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 Gulab jamun; 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.

Lecture Schedule

1. Status and significance of traditional Indian milk products in India.

2. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa.
3. Mechanization in manufacture of khoa.
4. Khoa based sweets: Burfi, Peda and their compositional profile and manufacture practices.
5. Khoa based sweets: Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices.
6. Rabri: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.
7. Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.
8. Channa: Product description, standards method of manufacture, packaging and preservation.
9. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai.
10. Mechanization of manufacturing process, advances in preservation and packaging.
11. Paneer: Product description, standards, method of manufacture, packaging and preservation.
12. Mechanization of Paneer manufacturing/packaging process.
13. Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects.
14. MistiDahi: Product description method of manufacture and packaging process.
15. Kheer and Payasam: Product description methods of manufacture, Innovations in manufacturing and packaging processes.
16. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.
17. Other products.

Practical Schedule

1. Preparation of Khoa from cow, buffalo and concentrated milk.
2. Preparation of Burfi.
3. Preparation of Peda.
4. Preparation of Kalakand.
5. Preparation of Milk cake.
6. Preparation of Gulabjamun.
7. Preparation of Paneer from cow, buffalo and mixed milk.
8. Preparation of Chhana from cow and buffalo milk and mixed milk.
9. Preparation of Sandesh.
10. Preparation of Rasogolla.
11. Preparation of kheer.
12. Preparation of Rabri.
13. Preparation of Misti Dahi.
14. Preparation of Chhana.
15. Preparation of Shrikhand.
16. Visit to industry.
17. Practical examination.

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.

EFT 4103 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. Acquire 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

Module I **(6 Hours)**

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

Module II **(11 Hours)**

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.

Module III **(10 Hours)**

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.

Module IV **(7 Hours)**

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.

Lecture Schedule

1. History and development of ice cream industry.
2. Status of ice cream industry.
3. Definition of ice cream.
4. Definition of other frozen desserts.
5. Classification of ice cream and other frozen desserts.
6. Composition of ice cream and other frozen desserts.
7. Standards of ice cream and other frozen desserts.
8. Stabilizers and emulsifiers- their classification.
9. Stabilizers and emulsifiers- Properties and role in quality of ice cream.
10. Technological aspects of ice cream manufacture.
11. Thermodynamics of freezing.
12. Calculation of refrigeration loads-I.
13. Calculation of refrigeration loads-II.
14. Types of freezers- Batch.
15. Types of freezers- Continuous.
16. Typical freezing curve.
17. Refrigeration control / instrumentation.
18. Hygiene, cleaning and sanitation of ice cream plant.
19. Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream.
20. Physico-chemical properties of ice-cream mix.
21. Processing of ice-cream mix.
22. Freezing of ice-cream mix.
23. Control of over run.
24. Packaging, hardening, storage and shipping of ice-cream.
25. Defects in ice cream.
26. Causes and prevention of defects.
27. Method of sensory evaluation of ice cream.
28. Recent advances in ice-cream industry.
29. Flavourings.
30. Colourings.
31. Fat replacers.
32. Bulking agents.
33. Plant management.
34. Nutritive value of ice-cream.

Practical Schedule

1. Preparation of Khoa from cow, buffalo and concentrated milk.
2. Preparation of Burfi.
3. Preparation of Peda.
4. Preparation of Kalakand.
5. Preparation of Milk cake.
6. Preparation of Gulab jamun.
7. Preparation of Paneer from cow, buffalo and mixed milk.
8. Preparation of Chhana from cow and buffalo milk and mixed milk.
9. Preparation of Sandesh.
10. Preparation of Rasogolla.
11. Preparation of kheer.
12. Preparation of Rabri.
13. Preparation of Misti Dahi.
14. Preparation of Chhana.
15. Preparation of Shrikhand.
16. Visit to industry.
17. Practical examination.

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, Dec 15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson, R.K. 1986. Modern Dairy Technology. Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson, R.K. 2002. Dairy Microbiology Handbook. 3rd edn. John Willey and sons, New York, USA.
8. Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th edn. Madison, Wisconsin, p 5-10.

ERE 4104 Energy Conservation and Management 2 (1+1)

Objective

1. 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

Module I **(5 Hours)**

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. Electrical load management: Demand management, energy management information systems, 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.

Module II **(5 Hours)**

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 conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment.

Module III **(7 Hours)**

Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; 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; Introduction to Solar, and Biomass Energy; Solar thermal and photo-voltaic energy options for food processing industries: 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.

Lecture Schedule

1. Energy management and audit: Definition, energy audit, need, types of energy audit.
2. Energy audit approach understanding energy costs, bench marking, energy performance, matching energy use to requirement.

3. Electrical load management: Demand management, energy management information systems.
4. Quality of power, Power factor and its improvement.
5. Transformers, losses in transformers; Energy savings in transformers.
6. Electric motor-selection and application, Energy efficient motors.
7. Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy.
8. Power saving guide with Star Ratings of electrical appliances, Induction Motors, Air conditioners, Refrigerators and Water Heaters.
9. Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls.
10. Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation.
11. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems.
12. Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment.
13. Processing equipment: Improving efficiency and energy conservation opportunities in important food processing operations.
14. Improving efficiency and energy conservation opportunities in Thermal processes, Evaporation, Drying and Freezing.
15. Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator.
16. Waste-heat recovery and thermal energy storage in food processing facilities.
17. Introduction to Solar, and Biomass Energy; Solar thermal and photo-voltaic energy options for food processing industries.
18. Incorporation of enhanced PLC based computer controls and SCADA.

Practical schedule

1. Study of Energy Conservation Act 2001.
2. Study of schemes of BEE.
3. Study of concepts of Energy Balance in Unit Operations and System boundaries.
4. Solving examples on energy balances.
5. Solving problems on electrical energy use and management.
6. Connected load, Maximum demand
7. Demand factor and Load curve.
8. Determination of Load factor of an installation.
9. Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter.
10. Study of use of power factor meter and determination of true power and wattles power by using Ammeter and Volt meter.
11. Study of performances of a general type of induction motor.
12. Study of performances of an energy efficient induction motor.
13. Study of use of VSD.
14. Study of various types of electrical appliances classified under different BEE Star Ratings.

15. Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency.
16. Exercise on energy audit of a Dairy plant.
17. Practical Examination.

Suggested readings

1. Jiři Klemeš, 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.
2. Lijun Wang 2008 Energy Efficiency and Management in Food Processing Facilities, CRC Press Inc; 1st edition (4 December 2008); Taylor and Francis.
3. Paul O'Callaghan 1993 Energy Management, McGraw- Hill Book Company Europe, Shppen hangers Road, England.
4. Tufail Ahmand 2012 Dairy Plant Engineering and Management, Kitab Mahal Publisher.

ERE 4105 Applications of Renewable Energy in Food Processing 2(1+1)

Objective

1. To equip students with the knowledge about the alternative and renewable sources of energy available for operating of a food processing industry

Theory

Module I (6 Hours)

Introduction to energy sources; Classification of renewable energy sources, utilization of these sources in food processing sector. Solar radiation, measurement of solar radiation, types of solar collectors and their uses; Familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; Utilization of solar thermal energy in food processing.

Module II (6 Hours)

Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry. Biomass and its characterization; briquetting of biomass. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry and biodiesel preparation.

Module III (5 Hours)

Importance of biogas technology, production mechanism, types of biogas plants, uses of biogas, handling and utilization of digested slurry. Use of food waste for biogas generation and its applications; Brief introduction to wind energy, hydroelectric energy, ocean energy.

Practical

Study of solar radiation measuring instruments; Study of solar cooker; Study of solar water heater; Study of solar dryer; Study of solar PV system; Estimation of calorific value of biomass; Estimation of moisture content of biomass; Estimation of ash content of biomass; Estimation of fixed carbon and volatile matter of biomass; Study of briquetting machine;

Demonstration of up draft gasifier; Demonstration of down draft gasifier; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum type biogas plants; Demonstration of biodiesel preparation; Demonstration of wind measuring instruments.

Lecture Schedule

1. Introduction to energy sources; classification of renewable energy sources.
2. Utilization of energy sources in food processing sector.
3. Solar radiation, measurement of solar radiation.
4. Types of solar collectors and their uses.
5. familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator.
6. Utilization of solar thermal energy in food processing.
7. Solar photovoltaic cells, modules, arrays.
8. Conversion process of solar energy into electricity, applications in food industry.
9. Biomass and its characterization.
10. Introduction to briquetting of biomass.
11. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry.
12. Biodiesel preparation.
13. Importance of biogas technology, production mechanism.
14. Types of biogas plants, uses of biogas, handling and utilization of digested slurry.
15. Use of food waste for biogas generation and its applications.
16. Introduction to wind energy.
17. Introduction to hydroelectric energy.
18. Introduction to ocean energy.

Practical Schedule

1. Study of solar radiation measuring instruments.
2. Study of solar cooker; Study of solar water heater.
3. Study of solar dryer.
4. Study of solar PV system.
5. Estimation of calorific value of biomass.
6. Estimation of moisture content of biomass.
7. Estimation of ash content of biomass.
8. Estimation of fixed carbon matter of biomass.
9. Estimation of volatile matter of biomass.
10. Study of briquetting machine.
11. Demonstration of up draft gasifier.
12. Demonstration of down draft gasifier.
13. Demonstration of working of a fixed dome type biogas plant.
14. Demonstration of working of a floating drum type biogas plant.
15. Demonstration of biodiesel preparation.
16. Demonstration of wind measuring instruments.
17. Practical Examination..

Suggested Readings

1. Khandelwal, K.C. and S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
2. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
3. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
5. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
6. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.

EFE 4101 Food Plant Design and Layout 3(2+1)

Objectives

1. To equip students to effectively design food processing plant incorporating the appropriate machinery, equipment, utility services, conforming to the legal standards.

Theory

Module I **(5 Hours)**

Introduction Classification of food processing plants, food plant design concepts, situations giving rise to plant design problems and general design considerations (technical, economic, legal, safety and hygiene). Feasibility Study Steps involved in feasibility study, collection of the information, information flow diagrams, market analysis, technical analysis and preparation of feasibility report.

Module II **(9 Hours)**

Plant location factors affecting plant location, their interaction with plant location, location theory models for evaluation of alternate locations. Plant size economic plant size, factors affecting the plant size (technical and economical), raw material availability, market demand, competition in the market, return on investment etc. Procedures for estimation of economic plant size (breakeven analysis and optimization), estimation of volume of production for each product. Product and process design; Design of product, product specifications, least cost mix of raw materials, process design, process selection considering technical, economic and social aspects. Process planning and scheduling, flow sheeting, flow diagrams and process flow charts including their design and computer aided development of flow charts.

Module III **(10 Hours)**

Selection of equipment process equipment, material handling equipment, service equipment, instruments and controls, considerations involved in equipment selection, economic analysis of equipment alternatives using optimization techniques and cash flows, economic decision on spare equipment, prediction of service life of the equipment. Plant layout types of layouts, considerations involved in planning an efficient layout, preparation and development of layout, evaluation of alternate layouts, use of computers in development and evaluation of layouts, equipment symbols, flow sheet symbols, electric symbols, graphic symbols for piping systems,

standards for space requirement and dimensions, distances between critical plant areas and for different plant facilities.

Module IV **(10 Hours)**

Planning and design of service facilities and plant surroundings requirements of the steam, refrigeration, water, electricity, waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection etc. Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring. Planning of offices, laboratories, lockers and toilet facilities, canteen, parking lots and roads, loading docks, garage, repair and maintenance shop, ware houses etc. Workers safety and health aspects falling hazards and safeguards, electric hazards, heat exposure, dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, personnel hygiene, sanitary requirements and standards, insect, rodent and bird control. Building and building materials requirements in respect of building type, wall, ceiling and floor construction, building height and building materials.

Practical

Prepare a feasibility report, prepare a plant location report, Case study analysis on basic plant layout concepts, Identifying hygienic zones and equipment placement, designing equipment placement for a production line, safety measures and routes in a plant layout study of design and layout of milk processing plant, Designing utility flow systems and positioning in the plant layout, Evaluation of different construction materials used in food plants, study of design and layout of fruit processing plant, To study design and layout of beverage plant, study design and layout of meat and meat products plant, To study design and layout of bakery and confectionery plant, study design and layout of grain processing plant, study design and layout of cold storage and warehouse, Incorporating eco-friendly features into plant layouts.

Lecture Schedule

1. Introduction classification of food processing plants.
2. Food plant design concepts.
3. Situations giving rise to plant design problems and general design considerations (technical, economic, legal, safety and hygiene).
4. Feasibility study steps involved in feasibility study, collection of the information.
5. Information flow diagrams, market analysis, technical analysis and preparation of feasibility report.
6. Plant location factors affecting plant location, their interaction with plant location, location theory models for evaluation of alternate locations.
7. Plant Size Economic plant size.
8. Factors affecting the plant size (technical and economical).
9. Raw material availability, market demand, competition in the market, return on investment etc.
10. Procedures for estimation of economic plant size (breakeven analysis and optimization).
11. Estimation of volume of production for each product.
12. Product and process design.

13. Design of product.
14. Product specifications, least cost mix of raw materials.
15. Process design, process selection considering technical, economic and social aspects.
16. Process planning and scheduling.
17. Flow sheeting.
18. Flow diagrams and process flow charts including their design and computer aided development of flow charts.
19. Selection of equipment process equipment.
20. Material handling equipment.
21. Service equipment, instruments and controls.
22. Considerations involved in equipment selection, economic analysis.
23. Optimization techniques and cash flows.
24. Economic decision on spare equipment.
25. Prediction of service life of the equipment.
26. Plant layout types of layouts.
27. Use of computers in development and evaluation of layouts, equipment symbols.
28. Standards for space requirement and dimensions, distances between critical plant areas and for different plant facilities.
29. Planning and design of service facilities.
30. Waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection etc.
31. Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring.
32. Planning of offices, laboratories, lockers and toilet facilities, canteen, parking lots and roads, loading docks, garage, repair and maintenance shop, ware houses etc.
33. Workers Safety and Health Aspects Falling hazards and safeguards, electric hazards, heat exposure, dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, personnel hygiene, sanitary requirements and standards, insect, rodent and bird control.
34. Building and building materials requirements in respect of building type, wall, ceiling and floor construction, building height and building materials.

Practical Schedule

1. Prepare a feasibility report.
2. Prepare a plant location report.
3. Case study analysis on basic plant layout concepts.
4. Identifying hygienic zones and equipment placement.
5. Designing utility flow systems and positioning in the plant layout.
6. Evaluation of different construction materials used in food plants.
7. Designing equipment placement for a production line.
8. Study of design and layout of milk processing plant.
9. Study of design and layout of fruit processing plant.
10. To study design and layout of beverage plant.
11. To study design and layout of meat and meat products plant.

12. To study design and layout of bakery and confectionery plant.
13. To study design and layout of grain processing plant.
14. To study design and layout of cold storage and warehouse.
15. Incorporating eco-friendly features into plant layouts.
16. Safety measures and routes in a plant layout.
17. Practical Examination.

Suggested Readings

1. Chemical Engineering Handbook by Perry R.H. Published by McGraw-Hill.
2. Chemical Engineering Plant Design by Villbrandt F.C. and Dryden C.E. Published by McGraw Hill.
3. Computer Aided Process Plant Design by Leesley M.E. Published by Gulf Publishing Company, Houston.
4. Engineering Economic Analysis by W.T. Morris. Published by Reston Publishing Company, Inc., New York.
5. Food Plant Economics by Z.B. Maroulis and G.D. Sarvacos. Published by CRC press.
6. Plant Design and Economics for Chemical Engineers by Peters M.S. and K.D. Timmerhaus. Published by McGraw-Hill.
7. Plant Layout and Design by J.M. Moore Published by The McMillan company.
8. Process Plant Design by Backhusrt J.R. and J.H. Barker. Published by Heimann Educational Books, London.
9. Project Feasibility Analysis by Clifton D.S. and D.E. Fyfee. Published by John Willey and Sons, New York.
10. Project Management for Engineers by M.D. Rosenau Published by Van Nostrand Reinhold Co., New York.

EFE 4102 Waste and By-Products Utilization 3(2+1)

Objectives

1. To enable the students to understand the nature of agricultural wastes and the physical, chemical and biological basis of agricultural waste treatment.
2. To analyse and design systems for the collection, handling, treatment and utilization of wastes.

Theory

Module I **(5 Hours)**

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.

Module II **(7 Hours)**

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, oxygen demands

(BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.

Module III **(10 Hours)**

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting.

Module IV **(12 Hours)**

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste. Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by-products.

Lecture Schedule

1. Types and formation of by-products and waste.
2. Magnitude of waste generation in different food processing industries.
3. Uses of different agricultural by-products from rice mill.
4. Uses of different agricultural by-products from sugarcane industry.
5. Uses of different agricultural by-products from oil mill and other food processing industries.
6. Concept, scope and maintenance of waste management and effluent treatment.
7. Waste parameters and their importance in waste management- temperature and pH.
8. Importance of oxygen demands (BOD, COD) in waste management.
9. Importance of fat, oil and grease content in waste management.
10. Metal content, forms of phosphorous and sulphur in waste waters.
11. Microbiology of waste water.
12. Insecticide, pesticides and fungicides residues in waste water.
13. Waste utilization in various industries.
14. Furnaces and boilers run on agricultural wastes and by products.
15. Briquetting of biomass as fuel.

16. Production of charcoal briquette.
17. Generation of electricity using surplus biomass.
18. Producer gas generation and utilization.
19. Waste treatment and disposal.
20. Design, construction, operation and management of institutional type biogas plants.
21. Design, construction, operation and management of community and family size biogas plants.
22. Vermi composting-introduction-advantages-concept-preparation.
23. Different Pre-treatment of waste -sedimentation and coagulation methods.
24. Different Pre-treatment of waste- flocculation and floatation.
25. Secondary treatments-biological and chemical oxygen demand for different food plant waste.
26. Secondary treatments- trickling filters and oxidation ditches.
27. Secondary treatments-activated sludge process-rotating biological contractors, lagoons.
28. Tertiary treatments- advanced waste water treatment process.
29. Filters for waste water treatment - sand, coal and activated carbon.
30. Phosphorous, sulphur, nitrogen and heavy metals removal from waste water.
31. Assessment, treatment and disposal of solid waste.
32. Effluent treatment plants.
33. Effluent treatment plants.
34. Environmental performance of food industry to comply with ISO-14001 standards.

Practical Schedule

1. Determination of temperature and pH of waste water.
2. Determination of turbidity of waste water.
3. Determination solids content of waste water.
4. Determination of fat and oil content in waste water.
5. Determination of BOD of waste water.
6. Determination of COD of waste water.
7. Determination of ash content of agricultural wastes.
8. Determination of un-burnt carbon in ash of agricultural waste.
9. Study about briquetting of agricultural residues.
10. Design of different biogas plant.
11. Estimation of excess air for better combustion of briquettes.
12. Study of extraction of oil from rice bran.
13. Study on bioconversion of agricultural wastes.
14. Recovery of germ and germ oil from by-products of cereals.
15. Study on advanced effluent treatment plants.
16. Visit to various industries using waste and food by-products.
17. Practical examination.

Suggested Reading

1. Bhatia, S. C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

2. Garg, S. K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
3. Joshi, V. K. and Sharma, S. K. 2011. Food Processing Waste Management: Treatment & Utilization Technology. New India Publishing Agency.
4. Markel, I. A. 1981. Managing Livestock Waste. AVI Publishing Co.
5. Pantastico, E. C. B. 1975. Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables. AVI Pub. Co.
6. Prashar, A. and Bansal, P. 2008. Industrial Safety and Environment. S.K. Kataria and Sons, New Delhi.
7. Shewfelt, R. L. and Prussi, S. E. 1992. Post-Harvest Handling - A Systems approach. Academic Press Inc.
8. USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
9. Vasso, O. and Winfried, R. (Eds) 2007. Utilization of By-products and Treatment of Waste in the Food Industry. Springer Science & Business Media, LLC 233 New York.
10. Weichmann, J. 1987. Post-Harvest Physiology of Vegetables. Marcel and Dekker Verlag.

EBE 4110 Instrumentation and Process Control in Food Industry 3(1+2)

Objectives

1. Learn different measurement and control parameters and instruments for their measurement.
2. Understand process control in food processing.

Theory

Module I **(5 Hours)**

Introduction, definitions, characteristics of instruments, static and dynamic characteristics, Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure. Liquid level measurement, different methods of liquid level measurement, flow measurement, differential pressure meters, variable area meters.

Module II **(7 Hours)**

Weight measurement: Mechanical scale, electronic tank scale, conveyor scale, Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples; Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware.

Module III **(2 Hours)**

Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis; Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices; Controllers and indicators

Module IV **(4 Hours)**

Temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing; Introduction of 8051/8085 based system and applications in processing.

Practical

Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature-controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer; 8051 based programming examples; Programmable Logic Controllers (PLC) Hardware; PLC Ladder programming; control of Multiprocess system.

Lecture Schedule

1. Introduction, definitions, characteristics of instruments, static and dynamic characteristics.
2. Temperature and temperature scales. Various types of thermometers; thermocouples, resistance thermometers and pyrometers.
3. Pressure and pressure scales, manometers, pressure elements differential pressure.
4. Liquid level measurement, different methods of liquid level measurement.
5. Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering.
6. Weight measurement: Mechanical scale, electronic tank scale, conveyor scale.
7. Measurement of displacement, temperature, velocity.
8. Measurement of force and pressure using potentiometer.
9. Resistance thermometer, thermocouples.
10. Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control systems.
11. Process control: Definition, simple system analysis, dynamic behavior of simple process.
12. Laplace transform, process control hardware.
13. Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis.
14. Transducers: Classification, self-generating transducers, variable parameter type digital, actuating and controlling devices.
15. Controllers and indicators: temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers.
16. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer.
17. Signal interfacing, examples in food processing.
18. Introduction of 8051/8085 based system and applications in processing.

Practical Schedule

1. Experimental study on instrumentation symbols.
2. Experimental study on instrumentation symbols-contd.
3. Determination of relative humidity by wet and dry bulb thermometer.
4. Determination of relative humidity by wet and dry bulb thermometer contd.
5. Measurement of wind velocity by anemometer.
6. Measurement of wind velocity by anemometer contd.
7. Measurement of intensity of sun shine by sunshine recorders.
8. Measurement of intensity of sun shine by sunshine recorders contd.
9. Study of characteristics of pressure transducers.
10. Study of characteristics of pressure transducers contd.
11. Real-time study of pressure transducers characteristics with PC.
12. Real-time study of pressure transducers characteristics with PC contd.
13. Characteristics of IC temperature sensor.
14. Characteristics of IC temperature sensor contd.
15. Characteristics of platinum RTD.
16. Characteristics of platinum RT contd..
17. Temperature-controlled alarm system.
18. Temperature-controlled alarm system contd..
19. Study of water level to current conversion.
20. Study of water level to current conversion contd..
21. Study of characteristics of capacitive transducer.
22. Study of characteristics of capacitive transducer contd.
23. 8051 based programming examples.
24. 8051 based programming examples contd.
25. Programmable Logic Controllers (PLC) Hardware.
26. Programmable Logic Controllers (PLC) Hardware contd.
27. PLC Ladder programming.
28. PLC Ladder programming contd.
29. Control of Multi-process system.
30. Control of Multi-process system contd.
31. Practical examination.

Suggested Readings

1. Bela G. Liptak. 2003. Instrument Engineer’s Handbook, Vol. I and II, 4th edn. CRC Press, Boca Raton, FL, USA.
2. Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th edn. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Don W. Green and Robert H. Perry. 2008. Perry’s Chemical Engineers’ Handbook. McGraw-Hill Co., Inc., NY, USA.
4. Murty, D.V.S. 2004. Transducers and Instrumentation. Prentice Hall of India Pvt. Ltd. New Delhi.

SKILL ENHANCEMENT COURSES

SFT --01 Introduction to Drying Technology and Dryers 2(0+2)

- Introduction to different types of dryers
- Experiment on cabinet drying
- Design of dryer, performance evaluation and drying kinetic studies.
- Experiment on Thin-Layer Drying
- Experiment on Deep bed drying
- Study on osmotic drying, Freeze drying, Infrared drying
- Plotting drying curves for different food products
- Study on heat pump drying
- Experiment on microwave drying
- Study on Novel dryers
- Drying of sliced vegetables (carrot) on refractance window drying
- Study of refractance window drying

SFT --02 Introduction to Processing of Extruded Foods 2(0+2)

- A brief study on different types of extruders
- Understanding extrusion technology, equipment handling, and troubleshooting extrusion processes
- Extruder machine operation, product formulation, and optimization of extrusion parameters
- Product formulation, quality assessment, advanced extrusion techniques, and food product development
- Advanced equipment management, process optimization, and scaling up extrusion processes for industrial use
- Understanding of food manufacturing practices, process automation, and quality control in extruded food products
- Extrusion cooking, innovative product development, ingredient modification, and food safety
- Snack formulation, texture and flavor development, market-oriented product design
- Food engineering, thermal processing, mechanical understanding of extrusion systems

SFT --03 Introduction to Milling (Rice, Dal, Spices, etc.) 2(0+2)

- Basics of grain milling, machine operation, and grain quality management.
- Rice milling techniques, equipment handling, rice quality control, and process optimization.
- Pulse milling technology, dal quality enhancement, machine operation, and pulse processing optimization.
- Spice grinding and milling, quality control in spice processing, contamination prevention, and packaging.

- Advanced milling techniques, equipment calibration, quality control, and yield improvement.
- Cereal and pulse milling technology, dehulling processes, milling equipment usage, and product development.
- Rice milling operations, by-product management, process improvement, and quality assurance.
- Grain structure analysis, milling technology, quality control, and product safety.
- Process optimization, equipment automation, product quality improvement, and loss minimization.
- Flour milling techniques, milling equipment operation, grain analysis, and quality control.

SFE --01 Introduction to Electrical and Control Systems in Food Industry 2(0+2)

- Electrical power supply and distribution in food plants
- Identification of common electrical components (circuit breakers, relays, motors)
- Hands-on exercise on electrical safety practices (Lockout/Tagout procedures)
- Measurement of voltage, current, and power in single-phase and three-phase systems using multimeters
- Demonstration of AC and DC motor operation
- Setup and programming of VFD for speed control in food processing machinery
- Identify control components (sensors, actuators, controllers)
- Hands-on exercise with basic ON/OFF control systems used in the food industry
- Calibration and testing of temperature and pressure sensors; Conduct an energy audit of a simulated food processing facility
- Measuring power quality parameters (harmonics, voltage dips) using power quality analyzers

SFE --02 Introduction to Mechanical Systems in Food Industry 2(0+2)

- Introduction to different types of mechanical systems in food processing (mixers, conveyors, packaging machines)
- Setting up a basic conveyor belt system
- Experiments with different materials to analyze the efficiency of various conveyors (belt, roller, screw conveyors)
- Hands-on work with different types of pumps (centrifugal, positive displacement)
- Measuring flow rates and pressure in a liquid transfer system
- Operation and analysis of a plate or shell-and-tube heat exchanger; Operating different size reduction equipment (grinders, mills, crushers)
- Capacity, design, operation & maintenance of stem boilers, air compressors, DG (diesel generator) set, soft water plant and other utilities

- Design a small-scale food processing line using conveyors, mixers, and packaging systems
- Design of belts, pulley, shafts, gear and other power transmission systems
- Design operation and maintenance of refrigeration system, cold storage and storage silos

SFE --03 Introduction to AutoCAD 2(0+2)

- Introduction for AutoCAD and use of the software for design of food processing machines and layout
- Understanding hardwares and softwares of CAD; Working with menu and files
- Working with snap, grid and pick commands; Working with creation of layers, changing colours and line types
- Drawing lines, circles, ellipse and arc; Editing the drawings-copy and rotate;
- Modifying the drawings-mirror, fillet and chamfer; Modifying the drawings-extend, stretch and trim commands
- Hatching the drawings and filling with patterns
- Working with measure, divide, block and insert commands; Working with text and dimensions
- Positioning the drawing, working with 3D objects and transforming 2D to 3D drawings
- Drafting of components like shafts and pulleys; Drafting of components like bins and hoppers
- Drafting of components of food processing equipment.

SFS --01 Introduction to Food Safety and Sanitation 2 (0+2)

- Designing of HACCP plan for food products
- ISO 22000 “Food Safety Management System”
- FSSAI Rules and Regulations
- BIS certification in food industry
- Good Manufacturing Practices (GMPS)
- Good Hygienic Practices (GHP)
- Bacteriological examination of water: Coliform MPN test
- Sampling of surfaces - equipment and physical plant
- Microbiological Examination of food products
- Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods.

SFS --02 Introduction of Good Laboratory Practices 2(0+2)

- Preparation of SOP (eg: milk and milk products)
- Basic laboratory regulations & accreditations (ISO, NABL etc.)
- Safety measures in a laboratory
- Laboratory waste management

- Management of emergency situations
- Stock verification, documentation and maintenance in the laboratory
- Calibration of laboratory equipment
- Validation of laboratory procedures
- Handling practices in the laboratory
- Sample preparation, analysis & documentation protocol.

SFS --03 Basic Food Analysis Laboratory Techniques 2(0+2)

- Safety measures in lab
- Weighing and preparation of solutions of different strengths and their dilution
- Preparation of media and methods of sterilization
- Use and handling of laboratory equipment
- Preparation of buffers of different strengths and pH values
- Nutritional evaluation of food
- Proximate analysis of food samples
- Rheological analysis of food materials
- Food product testing
- Adulteration “Detection & Control”

SFP --01 Maintenance of Food Processing Equipment 2(2+0)

- Introduction to food processing equipment and preparation of SOP
- Calibration and instrumentation
- Safety precaution for food processing equipment
- Equipment cleaning and sanitization
- Surface decontamination and disinfection procedure for processing equipment
- Good Manufacturing Practices (GMP), legislation and standards for food processing equipment
- Lubrication and cooling systems and electrical system maintenance
- Troubleshooting of mechanical issues, maintenance of pumps, valves and piping systems
- Safety and regulatory compliance
- Automation and control Systems.

SFP –02 Introduction to Bottling and Canning Line 2 (2+0)

- Overview of bottling and canning industry
- Bottling and canning equipment
- Packaging materials for bottling and canning and handling of packaging materials
- Design parameters for bottles and cans: shape, volume, strength and ergonomics.
- Design and analysis of a sample bottle/can using CAD software

- Filling technologies for bottles and cans (gravity filling, vacuum filling, pressure filling)
- Sealing, capping, labeling and coding systems
- Quality control: Inspection of finished products
- Cleaning and sanitizing of bottling, canning equipment, bottling and canning line
- Safety and regulatory compliance.

SFP –03 Introduction to Manufacturing of Bakery Products 2 (2+0)

- Baking and confectionery process and scope
- Bakery products- types (leavened and unleavened) and specifications
- Compositions, ingredients and their role in bakery products
- Formulations and processing of bakery products
- Equipment used in processing of bakery products
- Packaging, storage and quality testing of bakery products.
- Processing technology of bread and cakes
- Processing technology of biscuits
- Classification and manufacturing of biscuits and crackers
- Preservatives used in bakery, dosage and product quality specifications.

Online Courses

(6 credit hours)

Guidelines for taking the online courses

- The students will have to take a minimum of 6 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Food Technology) program.
- The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.
- The courses can be taken during the third year and 4th year of the UG program as per choice of students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.