Course Curriculum of First Semester

as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in

FOOD TECHNOLOGY

- UG-Certificate in Food Technology
- UG-Diploma in Food Technology
- UG-Degree: B.Tech. (Food Technology)

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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Layout

B.Tech. (Food Technology)

Semester: I (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**CAC-111**	*Deeksharambh* (Induction-cum-Foundation Course)	2(0+2)	NG (2 Weeks)
2.	**AEC-111**	National Service Scheme (NSS-I) / National Cadet Corps (NCC-I)	1(0+1)	
3.	**AEC-112**	Communication Skills	2(1+1)	
4.	**MDC-111**	Farming-based Livelihood Systems	3(2+1)	
5.	**MATH-111*/ BOT-111****	Basic Mathematics*/ Basic Botany**	2(2+0)	NG & Need-based
6.	**FT-111**	Fundamentals of Food Processing	3(2+1)	
7.	**FQA-111**	Food Chemistry-I	3(2+1)	
8.	**FQA-112**	General Microbiology	3(2+1)	
9.	**FE-111**	Post Harvest Engineering	3(2+1)	
10.	**SEC-111**	Skill Enhancement Course-I *(To be offered from the bouquet of SEC Courses)*	2(0+2)	
11.	**SEC-112**	Skill Enhancement Course-II *(To be offered from the bouquet of SEC Courses)*	2(0+2)	
		Total Credits Hrs.	**22(11+11) G 4(2+2) NG**	

CAC: Common Academic Course, AEC: Ability Enhancement Course, MDC: Multidisciplinary Course, SEC: Skill Enhancement Course, G: Gradial, NG: Non-Gradial

Note: *MATH-111 for PCB student/ **BOT-111 for PCM student/ PCMB student is NOT required to take any of these Need-based Courses.

B.Tech. (Food Technology): First Semester

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**I**	
Course No.	**:**	**CAC-111**	**Credit Hrs. : 2 (0+2) NG/ 2 Weeks**
Course Title	**:**	***Deeksharambh* (Induction-cum-Foundation Course)**	
Non-Gradial Common Academic Course for the said UG degree with the activities to be conducted during initial two weeks.			

Objectives:

(i) To create a platform for students to help for Cultural Integration of students from different backgrounds,

(ii) To know about the operational framework of academic process in the University, instilling life and social skills,

(iii) To create Social awareness, Ethics and Values, Team work, Leadership, Creativity,

(iv) To identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

ACTIVITIES

- Introduction/Orientation and Discussions on operational framework of academic process in University/ College, 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 example.
- Students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that exist in this area of food processing technology.
- Group activities to identify the strength and weakness of students and to learn from each other's life experiences.
- Activities to enhance Cultural Integration of students from different backgrounds.
- Field visits to the relevant fields/ establishments.
- Sessions on Personally Development (Instilling Life and Social skills, Social awareness, Ethics and Values, Team work, Leadership etc.) and imbibing the Communication skills.

Note: *The details of the relevant activities will be decided by the parent University in line with the above-mentioned broad activities.*

Semester : I		
Course No. : AEC-111	**Credit Hrs. : 1(0+1)**	
Course Title : National Service Scheme (NSS-I) / National Cadet Corps (NCC-I)		
Gradial Common Course across all UG degrees		

Course No.: AEC-111	**Course Title: National Service Scheme-I (NSS-I)**	**Credit Hrs.: 1(0+1)**

SYLLABUS

PRACTICAL

Introduction and Basic Components of NSS

- Orientation: History, Objectives, Principles, Symbol, Badge; Regular Programs under NSS.
- Organizational structure of NSS, Code of conduct for NSS volunteers, Points to be considered by NSS Volunteers' awareness about Health.
- NSS program activities. Concept of regular activities, Special camping, Day camps, Basis of adoption of village/slums, Conducting survey, Analysing Guiding financial patterns of scheme, Youth program/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth; and Opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership. Social harmony and National integration.
- Indian history and culture, role of youth in nation building, Conflict resolution and peace building. Volunteerism and Shramdaan. Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.
- Citizenship, Constitution, and Human rights. Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information. Family and Society. Concept of family, Community (PRIs and other community-based organizations) and Society.

TEACHING SCHEDULE

PRACTICAL [AEC-111]

Exercise No.	Exercise Topic	Weightage (%)
1	Orientation, History, Objectives, Principles, Symbols, Badge	10
2	Regular Programmes under NSS	10
3	Organisational Structure of NSS	10
4	Code of Conduct of NSS Volunteer	10
5	Points to be considered about NSS Volunteers awareness about Health	5
6	NSS Programme Activities- Concept of Regular activities	5
7	NSS Programme Activities- Special Campaign	5
8	NSS Programme Activities- Day Camps	5
9	NSS Programme Activities- Adoption of village, Conducting survey, Analysing Guiding financial patterns of scheme	5
10	NSS Programme Activities- Youth programs/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth and Opportunities for youth who is agent of the social change.	5
11	Community Mobilization- Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership.	5
12	Community Mobilization-Culture, Social harmony and National integration.	5
13	Indian History and Culture- Role of youth in Nation Building	5
14	Volunteerism and Shramdaan: Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.	5
15	Citizenship, Constitution and Human Rights: Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information.	5
16	Family and Society: Concept of family, Community (PRIs and other community-based organizations) and Society.	5
	Total=	**100**

Course No.: AEC-111	Course Title: National Cadet Corps-I (NCC-I)	Credit Hrs.: 1(0+1)

SYLLABUS

Objective: To integrate and develop qualities of leadership, discipline, character and patriotism and foster the NCC Motto: **"Unity and Discipline"** among the youth.

PRACTICAL

- Aims, Objectives, Organization of NCC and NCC Song. DG's Cardinals of Discipline.
- Drill- aim, General words of command, Attention, Stands-at-ease, Stand-easy and Turning.
- Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.
- Saluting at the halt, Getting on parade, Dismissing and Falling-out.
- Marching, Length of pace and time of marching in quick/slow time and halt. Side pace, Pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, Forward march and halt. Changing step, Formation of squad and squad drill.
- Command and control, Organization, Badges of rank, Honours and Awards.
- Nation Building- Cultural heritage, Religions, Traditions and Customs of India. National integration. Values and ethics, Perception, Communication, Motivation, Decision making, Discipline and duties of good citizens. Leadership traits, Types of leadership. Character/ Personality development. Civil 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.

TEACHING SCHEDULE

PRACTICAL [AEC-111]

Exercise No.	Exercise Topic	Exercise Sub-topics	Weightage (%)
1-2	Introduction to NCC	Aims, Objectives, NCC Organizational structure, NCC Song, DG's Cardinals of Discipline.	4
3-5	Drill Basics	Aim of drill, General words of command, Positions of attention, Stand-at-ease and Stand-easy, Turning.	8
6-8	Formation Drills	Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.	8
9-11	Saluting Drills and Parade Movements	Saluting at halt, Getting on parade, Dismissing and Falling-out.	8
12-14	Marching Techniques	Length of pace and time of marching in Quick/slow march, Side pace, Forward/rear pace, Turning on the march, Wheeling and Saluting on the march	10
15-17	Squad Formation and Control	Marking time, Forward march, Halt, Changing step, Formation of squad and Squad drill.	10
18-19	Command and Control in NCC	Organization, Badges of rank, Honours and Awards.	4
20-22	Nation Building and Citizenship; Leadership	Cultural heritage, Religions, Traditions, Customs of India, National integration, Values and Ethics, Communication, Leadership traits, Discipline and Motivation, Character/ Personality Development.	12
23-24	Civil Defence and Emergency Management	Types of emergencies, Fire fighting techniques, Maintenance of essential services, Disaster management and Aid during development projects, Civil Defence Organizations.	10
25-26	Social Service and Youth Welfare	Weaker sections of society, Role of NGOs, Youth participation in Social welfare and Family planning	8
27-29	Health, Hygiene and First Aid	Human body structure, Diet, Hygiene, Preventable diseases (including AIDS), Safe blood donation, First aid practices, Mental and Physical health.	10
30-32	Environment and Ecology	Basic Principles of Ecology, Environmental conservation, Pollution and its control, Adventure activities.	8
		Total =	**100**

Semester	**:**	**I**		
Course No.	**:**	**AEC-112**	**Credit Hrs.**	**: 2(1+1)**
Course Title	**:**	**Communication Skills**		
Gradial Common Course across all UG degrees				

SYLLABUS

Objectives:(i) To acquire competence in oral, written and non-verbal communication

(ii) To develop strong personal and professional communication and

(iii) To demonstrate positive group communication.

THEORY

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and Non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/Abstracting/Summarizing; Style of technical communication, Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions; Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; Phrases and clauses; Case: subjective case, possessive case, objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [AEC-112]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Communication Process: The Magic of Effective Communication	Elements of Communication process such as Communicator, Message and Channel treatment of message, Audience and Audience response.	5
2	Building Self-esteem and Overcoming Fears	Points to build Self-esteem, Build social connections, Encourage yourself, Focus on solutions and Set realistic goals, Strategies to overcome fears, Practice, Visualise Success, Preparation, Know your audience, Seek feedback and Active listening.	5
3	Communication	Concept, Nature and Significance of Communication process	10
4		Meaning, Types and Models of communication	10
5		Verbal and Non-verbal communication, Linguistic and Non-linguistic communication	10
6		Barriers to communication and Reasons behind communication gap/ miscommunication	5
7	Basic Communication Skills	Listening, Speaking, Reading, Writing skills	5
8		Precis writing/ Abstracting/ summarizing- Styles of technical communication, Curriculum Vitae/resume writing	10
9		Innovative methods to enhance vocabulary, analogy questions	5
10	Structural and Functional Grammar	Sentence structure, modifiers, connecting words and verbal; Phrases and Clauses	5
11		Case: Subjective case, Possessive case, Objective case	5
12		Correct usage of nouns, Pronouns and Antecedents	5
13		Adjectives, Adverbs and Articles	5
14		Agreement of verbs with the subject: Tense, Mood, Voice	5
15		Writing effective sentences	5
16		Basic sentence faults	5
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [AEC-112]

Exercise No.	Exercise Topic
1	Listening and Note taking
2	Writing skills- Precis writing
3	Writing skills- Abstracting
4	Writing skills- Summarizing
5	Reading and Comprehension (written and oral) of general and technical articles
6	Micro-presentations
7	Impromptu presentations
8	Feedback on presentations
9	Stage manners- Grooming
10	Stage manners- Body language
11	Stage manners- Voice modulations, speed
12	Group discussions
13	Public speaking exercise
14	Vocabulary building exercises
15	Interview techniques
16	Organisation of events

Suggested Readings [AEC-112]:

1. **Allport, G W. 1937.** Personality: A Psychological Interpretation. Holt, New York.
2. **Brown, M. and Gyles, B. 1994.** How to Interview and be Interviewed. Sheldon Press, London.
3. **Dale, C. 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, L. 2011.** Communication Skills. Oxford University Press.
6. **Neuliep, J.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. **Ray, G L, 2008**. Extension, Communication and Management. Kalyani Publishers,Ludhiana
10. **Ray, G.L. and Mondal S. 2012.** Textbook on Rural Development Entrepreneurship and Communication Skills. Kalyani Publishers, Ludhiana.
11. **Seely, J. 2013.** Oxford Guide to Effective Writing and Speaking. Oxford University Press.
12. **Thomson, A.J. and Martinet, A.V. 1977.** A Practical English Grammar. Oxford University.

Semester	**:**	**I**	
Course No.	**:**	**MDC-111**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Farming-based Livelihood Systems**	
Gradial Common Course across all UG degrees			

SYLLABUS

Objectives: (i) To make the students aware about farming-based livelihood systems in Agriculture

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

THEORY

Status of Agriculture in India and different States, Income of farmers and Rural people in India, Livelihood-Definition, Concept and Livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural Livelihood Systems (ALS): Meaning, Approach, Approaches and Framework, Definition of farming systems and farming-based livelihood systems, Prevalent Farming systems in India contributing to livelihood. Types of Traditional and Modern farming systems. Components of farming system/ farming-based livelihood systems: Crops and Cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agroforestry systems, Aquaculture, Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.; Small, Medium and Large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country; Case studies on different livelihood enterprises associated with the farming. Risk and Success factors in farming-based livelihood systems, Schemes and Programs by Central and State Governments; Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, Green economy, Climate change, Digitalization and Changing life style.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [MDC-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Status of Agriculture in India	Historical background, Current status, Role of Agriculture in Indian Economy	4
2	Status of Agriculture in Different States	State-wise scenario, Major crops, Regional diversity	4
3	Income of Farmers and Rural People in India	Factors affecting income, Rural-urban income gap, Government initiatives	4
4	Livelihood: Definition, Concept, and livelihood Patterns in urban and rural areas	Livelihood- Definition and its Concept, Urban vs Rural livelihood patterns, Sources of income	4
5	Different Indicators to Study Livelihood Systems	Economic, Social and Environmental indicators, Measuring livelihood resilience	4
6	Agricultural Livelihood Systems (ALS): Meaning and Approaches	Definition, Significance of ALS, Integrated farming systems, Approaches	4
7	ALS Framework and Case studies	Framework for ALS, Case studies in India	4
8	Definition of Farming Systems and farming based Livelihood Systems	Definition and Role of farming systems in rural livelihoods, Examples of systems	4
9	Prevalent Farming Systems in India contributing to livelihood	Traditional vs. Modern farming systems, Regional differences	4
10	Types of Traditional and Modern Farming Systems	Types; Differences; Strengths, Limitations, Case studies	4
11	Components of farming system/farming-based livelihood systems - Crops and Cropping Systems	Components, Crop diversification, Cropping pattern, Mixed cropping, Importance for rural livelihoods	4
12	Livestock-based Farming Systems	Importance and Management of dairy, piggery, poultry, goatry, duckry, etc.	4
13	Horticultural Crops and Livelihoods	Role of fruits, vegetables and spices in rural income generation	4
14	Agroforestry Systems	Agroforestry- Definition, Combining trees and crops, Agroforestry models in India	2
15	Aquaculture as a Livelihood System	Importance of Aquaculture, Integrated systems (e.g. Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.)	4
16	Challenges in Aquaculture-based Systems	Feasibility, Government support and Market access	2

Continued….

17	Small Enterprises in Farming	Role of small enterprises, Value addition, Local processing	2
18	Medium and Large Enterprises in Farming	Value chains, Secondary enterprises as livelihood components for farmers, Agri-processing.	2
19	Factors affecting Integration of various enterprises of farming for livelihood	Technology, Market access, Credit and infrastructure challenges etc.	4
20	Strategies for Enterprise Integration	Successful integration, Government policies, Examples.	2
21	Overview of Agro-Climatic Zones in India	Characteristics of different zones and their agricultural potential.	2
22	Feasibility of different Farming Systems for different Agro-Climatic Zones	Suitable farming systems for different zones, Climate adaptation.	2
23	Commercial Farming Based Livelihood Models by NABARD, ICAR and other organizations across the country	Role of NABARD, ICAR and other Organizations in promoting commercial models, Successful cases.	4
24	Case studies on different Livelihood Enterprises associated with farming	Analysis of successful enterprises, Dairy Cooperatives etc.	4
25	Risk Factors in Farming-based Livelihood Systems	Climate, Market fluctuations, Input costs; Mitigation strategies etc.	4
26	Success Factors in Farming-based Livelihood Systems	Innovation, Market access, Government support, Social capital etc.	2
27	Schemes and Programmes by the Central Government	Overview of schemes like, PM-KISAN, National Rural Livelihood Mission.	2
28	Schemes and programmes by State Governments	State-specific programs promoting rural livelihoods, Case examples.	2
29	Role of Private Sector in Livelihood Promotion	Public-Private Partnerships, Role of private agribusiness.	2
30	Public-Private Partnerships in Agriculture	Successful collaborations in rural development and farming systems	2
31	Farming-based Livelihoods in the 21st Century	Circular economy, Green economy, Climate change, Sustainability.	2
32	Impact of Digitalization and Changing Lifestyles	Technology in Agriculture, Future prospects for rural livelihoods.	2
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-111]

Exercise No.	Exercise Topic	Exercise Sub-topics/ Title
1	Survey of Farming Systems and Agriculture-based Livelihood Enterprises	Methods of data collection; Field survey techniques; Preparing reports on surveyed farms.
2	Study of Components of Farming-based Livelihood Models in Different Agro-Climatic Zones	Components: Crop, livestock, fishery, agroforestry; Identifying models suited to specific zones.
3	Study of Production and Profitability of Crop-based Models	Analysis of input-output relations; Identifying profitable crops
4	Study of Livestock-based Models	Livestock systems: Dairy, poultry, goat farming; Profitability and market access
5	Study of Processing-based Models	Value addition in agriculture; Studying small-scale food processing units
6	Study of Integrated Farming-based Models	Study of crop-livestock-aquaculture integration; Synergies and challenges
7	Field Visit to Innovative Farming System Models	Visit to farms using modern technologies; Documenting practices
8	Visit to Agri-based Enterprises	Enterprises involved in input supply or value addition
9	Study of Functional Aspects: Integration of Production, Processing and Distribution	Backward and forward linkages; Assessing supply chain models
10	Agri-Enterprises in Industry and Service Sectors (Value Chain Models)	Studying value chain enterprises; Evaluating sustainability models
11	Concept of Project Formulation on Farming-based Livelihood Systems	Identifying project objectives; Structuring budgets and timelines
12	Cost and Profit Analysis of Farming-based Livelihood Projects	Developing Cost-Benefit analysis; Identifying Break-Even points
13	Case Study of Start-ups in Agri-sectors	Analyzing real-world Start-ups; Identifying success factors
14	Group Project: Develop a Farming-based Livelihood Model	Formulating a working model; Feasibility and sustainability analysis
15	Preparation of Report on Farming Systems Survey and Livelihood Models	Compiling field data; Preparing reports with recommendations
16	Presentation and Evaluation of Practical Project Reports	Group presentations; Internal assessment of reports and participation

Suggested Readings (MDC-111):

1. **Ashley, C. and Carney, D. 1999**. *Sustainable Livelihoods: Lessons from Early Experience.* Department for International Development, London, UK.
    - **Relevance**: This book explores sustainable livelihood frameworks, which are key to understanding livelihood patterns and rural income systems.
2. **Agarwal, A. and Narain, S. 1989**. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development.* Centre for Science and Environment, New Delhi, India.
    - **Relevance**: Provides strategies for participatory rural development, focusing on environmental sustainability—a core concept in farming systems.
3. **Carloni, A. 2001**. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa.* FAO, Rome, Italy.
    - **Relevance**: Offers insights into global farming system challenges, with lessons that can be adapted for Indian contexts in agricultural development.
4. **Dixon, J., Gulliver, A. and Gibbon, D. 2001**. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World.* FAO & World Bank, Rome & Washington, DC.
    - **Relevance**: Focuses on farming systems' role in poverty alleviation and rural livelihood improvement.
5. **Evenson, R.E. 2000**. *Agricultural Productivity and Production in Developing Countries.* In *FAO, The State of Food and Agriculture.* FAO, Rome, Italy.
    - **Relevance**: Discusses agricultural productivity, a critical factor in sustainable farming and improved livelihoods.
6. **Bhatt *et al*. (ICAR Research Complex for Eastern Region)**. *Livelihood Improvement of Underprivileged Farming Community: Experiences from Bihar.* Patna, Bihar.
    - **Relevance**: Case studies on improving livelihoods in rural India, relevant to learning about region-specific agricultural interventions.
7. **Panwar *et al.*, 2020**. *Integrated Farming System Models for Agricultural Diversification, Enhanced Income, and Employment.* Indian Council of Agricultural Research, New Delhi.
    - **Relevance**: Provides models for agricultural diversification and income enhancement, which align with farming system topics.
8. **Reddy, S.R., 2016**. *Farming System and Sustainable Agriculture.* Kalyani Publishers, New Delhi.
    - **Relevance**: Covers sustainable agriculture principles and farming system models, essential for sustainable livelihood systems.
9. **Singh *et al.*, 2015**. *Region Specific Integrated Farming System Models.* ICAR-Indian Institute of Farming Systems Research, Modipuram.
    - **Relevance**: Discusses integrated farming models tailored to different agro-climatic regions of India, essential for practical learning.
10. **Walia, S.S., and Walia, U.S., 2020**. *Farming System and Sustainable Agriculture.* Scientific Publishers, Jodhpur, Rajasthan.
    - **Relevance:** Provides insights into sustainable agricultural practices and integrated farming systems with regional focus.

Semester	**:**	**I**	
Course No.	**:**	**MATH-111***	**Credit Hrs. : 2(2+0) Need-based; G/NG**
Course Title	**:**	**Basic Mathematics**	
***Gradial** Need-based Common Course for **B.Tech. (Biotechnology)**; ***Non-Gradial** Need-based Common Course for **B.Tech. (Agril. Engg.)** & **B.Tech. (Food Technology)**			

SYLLABUS

Objectives:

(i) To study the basic principles and functions in mathematics like limits and continuity,

(ii) To study differentiation and integration,

(iii) To study matrices and determinants.

THEORY

Functions:

Function and types of functions, Limit: Introduction, left-handed and right-handed limits, Algebra of limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions. Continuity of trigonometric and exponential functions.

Differentiation:

Differentiation by the first principle, Rules of Differentiation: sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, maxima and minima.

Integration:

Definition of indefinite integrals, Integrals of elementary functions (Formulae only), Theorems of integration (without proof), Integration by substitution, integration by partial fractions, integration by parts, Definition of definite Integral with examples, properties of definite integral (without proof).

Matrices and Determinants:

Definition of determinants, example up to Third order determinant, properties of determinant (statements only), Definition of matrix, types of matrices, Algebra of Matrix (addition, subtraction and multiplication), inverse of matrix, Solution of linear equations by Crammer's rule.

Teaching Schedule

THEORY

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1-5	**Functions:**	Definition of Function, Types of functions	15
		Some Basic Functions: Definition and Properties of: Constant Function, Identity Function, Power Function. Polynomial Function, Linear, quadratic and cubic function, Radical Function, Rational Function. Exponential, Logarithmic and Trigonometric Function	
	Limit:	Introduction, Definition of Limit, left-handed and right-handed limits, Algebra of limits	
		Standard limits: Method of Factorization, Rationalization, Limit of Trigonometric, Exponential Logarithmic and Functions. Limit of Infinity	
	Continuity:	Definition of continuity, Continuity of algebraic functions, Continuity of trigonometric and exponential functions.	
6 -15	**Differentiation:**	Definition, Differentiation by the first principle, Derivative of Some standard functions (Formulae only), Rules of Differentiation (Sum, Difference, Product and quotient without proof), Differentiation using the chain rule, Differentiation of functions in parametric and implicit form, Logarithmic Differentiation, Successive differentiation, Maxima and minima	30
16 -25	**Indefinite and Definite Integration**:	Definition of indefinite Integral, Integrals elementary functions (Formulae only) Theorems of integration (without proof) Methods of Integration: Integration by Substitution, Integration by parts, Integration by partial fractions Some special integrals formulae only. Definition of definite Integral with examples Properties of definite integral (Without proof)	30
26 -32	**Determinants and Matrices:**	Definition of determinants, Expansion up to third order determinant, Properties of determinant (statements only) Definition of matrix, Order of Matrix, Types of matrices, Algebra of Matrices, Inverse of matrix by elementary transformations, Solution of linear equations by Crammer's rule	25
		Total=	**100**

Suggested Readings:

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. A Text book of Mathematics XI and XII (Part I and II) Maharashtra State Board of Secondary and Higher Secondary Education, Pune.
3. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

Semester	**:**	**I**		
Course No.	**:**	**BOT-111****	**Credit Hrs. : 2(2+0)**	**Need-based; G/NG**
Course Title	**:**	**Basic Botany**		
Need-based Common Course across 3 UG Degrees: **B.Tech. (Biotech.) - Gradial / B.Sc. (Hons.) A.B.M. - Gradial / B.Tech. (Food Tech.) - Non-Gradial				

SYLLABUS

Objectives: i. To study the basic taxonomy and classification of plants,
ii. To study the features of plant kingdom and morphology,
iii. To study the internal structure of plants.

THEORY

Plant Kingdom and features of each group. Plant taxonomy, Systems of classification. Morphology, Modifications and Functions of Root, Stem, Leaf, Flower and Inflorescence. Pollination and Fertilization. Fruit types. Structure of dicot and monocot seed, and seed germination. Cell structure. Chromosome, DNA and Genes. Cell and tissue types. Internal structure of root, stem and leaf. Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

TEACHING SCHEDULE

THEORY

Lecture No.	Topics	Sub-topics/ Key Points	Weightage (%)
1-3	Plant Kingdom and Features:	Classification of Plant Kingdom (Major plant groups: Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms.) Key distinguishing features/ characteristics of each group with examples. Plantae Kingdom.	8
4-5	Plant Taxonomy and Systems of Classification:	Binomial nomenclature and other systems of classification (in brief)	5
6-7	Plant Cell and Tissue Types:	Basic Structure of a Plant Cell and Tissue, Types of Plant Cells and Tissues; Plant Cell Functions.	8
8-9	Chromosome**:**	Definition and Overview, Chemical Composition; Chromosome Morphology, Types of Chromosomes**.**	8

Continued…

10-11	DNA:	Brief historical overview of DNA discovery, Watson-Crick model of DNA, Chemical composition, Components of a nucleotide, Structures of Purines and Pyrimidines.	8
12	Genes:	Definitions (Gene, Allele, Genotype, Phenotype, Exon, Intron, Codon) and Historical Overview; Structure: Basic layout of a gene- (Exon, Intron, etc.); Types of genes, Codons (Start/ Stop).	8
13-14	Pollination and Fertilization:	Definitions/Terminology, Types, Agents of pollination, Processes/Events, Significances, Barriers to Fertilization, Differences between their types.	10
15-16	Root and Stem:	Morphology, Modifications with examples and Functions	8
17-19	Leaf, Flower and Inflorescence**:**	Morphology, Modifications with examples and Functions	8
20	Fruits:	Types of fruits with examples	3
21-22	Structures of Monocot and Dicot Seeds:	Structure, Diagrams, Differences	5
23-24	Seed Germination:	Definitions, Types, Differences and Stages of seed germination	5
Plant taxonomy-Classification; Characteristics and Economic Importance; Members/ Examples of following Families viz.,			
25-26	Poaceae and Brassicaceae		4
27-28	Fabaceae and Malvaceae		4
29-30	Rutaceae and Rosaceae		4
31-32	Asteraceae and Solanaceae		4
		Total=	**100**

Suggested Readings [BOT-111]:

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th Edn, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi Publications.
3. Bhatia KN and Tyagi MP, 2020, Elementary Biology. A Truemen Publication.
4. David M Hillis, H Craig Heller, Sally D Hacker, David W Hall, David E Sadava, 2020. (eBook) Life: The Science of Biology, 12th Edn, Sunderland Publication.
5. Dutta AC, 1995, A Class-Book of Botany, 16th Edn, Oxford University Press.
6. NCERT, 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A Textbook of Botany Angiosperm. S. Chand Publications.

Semester	**:**	**I**			
Course No.	**:**	**FT-111**	**Credits Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Fundamentals of Food Processing**			

SYLLABUS

Objectives: (i) To gain an understanding of the perishability of food and causes for food spoilage,
(ii) To have an idea of the basic methods of preservation of food and
(iii) To impart knowledge about non-thermal processing of food.

THEORY

Food: Definition and Functions, Classification of foods, sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation. Food processing: Introduction, levels and techniques; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle, process and equipment for blanching, canning, pasteurization, sterilization. Preservation by use of low temperature: Principle, methods, equipments. Preservation by drying, dehydration and concentration: Principle, methods, equipments. Preservation by irradiation: Principle, methods, equipments. Preservation by chemicals-antioxidants, mould inhibitors, antibodies, acidulants, Hurdle technology etc. Preservation by fermentation: Principles, methods, equipments. Non-thermal preservation processes: Principles, equipment- Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc. Quality tests and shelf-life of preserved foods.

PRACTICAL

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- Pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

TEACHING SCHEDULE

THEORY [FT-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-2	Food	i) Definition and Functions, ii) Classification of foods, sources, iii) Types and perishability of foods iv) Causes and types of food spoilage v) Scope and benefit of food preservation.	10
3-5	Food processing	i) Introduction, levels and techniques ii) Methods of food preservation iii) Preservation by salt and sugar: Principle, method and effect on food quality.	10
6-8	Preservation by heat treatment	Principle, process and equipment for blanching, canning, pasteurization, sterilization.	10
9-12	Preservation by use of low temperature	Principle, methods, equipment.	14
13-14	Preservation by drying, dehydration and concentration	Principle, methods, equipment.	8
15-16	Preservation by irradiation	Principle, methods, equipment.	8
17-19	Preservation by chemicals.	Antioxidants, mould inhibitors, antibodies, acidulants, Hurdle technology etc.	5
20-21	Preservation by fermentation	Principles, methods, equipment.	5
22-25	Quality tests and shelf-life of preserved foods.	Physico-chemical, Sensory attributes shelf-life determination by using two methods i.e. Real time shelf life and Accelerated shelf life.	10
26-32	Non-thermal preservation processes	Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc.	20
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FT-111]

Exercise No.	Exercise Title
1	Demonstration of various perishable food items and degree of spoilage
2	Blanching of selected food items
3	Preservation of food by heat treatment- 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 i.e. Pickling by acid, vinegar or acetic acid
7	Preservation of food by using chemical preservatives
8	Preservation of bread and cake using mold inhibitors
9	Drying of fruit slices- pineapple slices and 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
14	Demonstration of preserving foods under cold vs. freezing process
15	Processing of foods using fermentation technique, i.e. preparation of sauerkraut
16	Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

Suggested Readings [FT-111]:

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. Fellows, P. 2000.
3. 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. Rahman, M.S. 2007. Handbook of Food Preservation. 2nd edn. CRC Press, Boca Raton, FL, USA. Stavros Y. 2008.
7. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA. Tewari, G. and Juneja, V.K. 2007.
8. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
9. Zeuthen, P. and Bùgh-Sùrensen, L. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.

Semester	**:**	**I**			
Course No.	**:**	**FQA-111**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Food Chemistry-I**			

SYLLABUS

Objectives:

(i) To learn the chemical aspects of food and bio-materials and its importance in food processing,
(ii) To gain an understanding of various water and macro-molecules and
(iii) To have an idea of about the effect of processing on these biomolecules.

THEORY

Water; Moisture in foods, Role and type of water in foods, Functional properties of water, Water activity and Sorption isotherm, Molecular mobility and Foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems. Carbohydrates; Monosaccharaides, Disaccharides and Polysaccharides, Modification of carbohydrates, Dietary fibers and Carbohydrates digestibility; Enzymatic and Chemical reactions of carbohydrates. Proteins in foods: Proteins-Classification, Structure and Properties; Proteins and Nutrition, Functional properties of proteins; Processing induced, Physical, Chemical and Nutritional changes in protein; Chemical and Enzymatic modification of protein. Lipids in foods: Classification, structure and properties of lipids; Role and use of lipids/fat, Crystallization and Consistency, Chemical aspects of lipids, Lipolysis, Auto-oxidation, Thermal decomposition, Chemistry of frying technology of fat and oil; Oil processing: Refining, Hydrogenations, Inter esterification, Use of oils and Fats in food formulation. Enzymatic and Chemical reactions of fats; Rancidity and its types, Detection techniques, Chemical aspects of lipids, Antioxidants.

PRACTICAL

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and Solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by Micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and Concentrate of proteins; Determination of Acid value, Saponification value and Iodine number of fat/oil; Assay of amylases, Papain and Lipases.

TEACHING SCHEDULE

THEORY [FQA-111]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1-6	Water	1. Moisture in foods, Role and Types of water in foods, Functional properties of water. 2. Water activity and sorption isotherm, Molecular mobility and Foods stability. 3. Dispersed systems of foods. 4. Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations). 5. Rheology of diphase systems.	20
7-13	Carbohydrates	1. Monosaccharides, Disaccharide and Polysaccharides, 2. Modification of carbohydrates, 3. Dietary fibers and Carbohydrates digestibility. 4. Enzymatic and Chemical reactions of carbohydrates.	20
14-19	Proteins in foods	1. Classification, Structure and Properties, 2. Proteins and Nutrition, 3. Functional properties of proteins, 4. Processing induced Physical, Chemical and Nutritional changes in protein, 5. Chemical and Enzymatic modification of protein.	20
20-26	Lipids in foods	1. Classification, Structure and Properties of lipids. 2. Role and Use of lipids/fat. 3. Crystallization and Consistency. 4. Chemical aspects of lipids, Lipolysis, Auto-oxidation, Thermal decomposition. 5. Chemistry of frying technology of fat and oil. 6. Oil processing: Refining, hydrogenation's, Inter esterification, Use of oils and fats in food formulation.	25
27-32	Enzymes	1. Enzymatic and Chemical reactions of fats, 2. Rancidity and its types, 3. Detection techniques, 4. Chemical aspects of Lipids, Antioxidants.	15
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [FQA-111]

Exercise No.	Exercise Title
1	Study of laboratory equipments/ apparatus
2	Determination of moisture content of foods using different methods
3	Qualitative test for carbohydrates
4	Qualitative test for amino acids
5	Qualitative test for proteins: (Salting out test, acid precipitation of protein test)
6	Qualitative test for lipids/fats
7	Studies of sorption isotherm of different foods
8	Swelling and solubility characteristics of starches
9	Determination of total sugar and reducing sugar in food
10	Determination of crude proteins by Micro-Kjeldhal method
11	Preparation of protein isolate and concentrate of proteins
12	Test for detection of different oils (Baudouin test, Halphens test)
13	Test for detection of different oils (Hexabromide test)
14	Determination of Acid value of fat/oil
15	Determination of Saponification value and Iodine number of fat/oil
16	Experiments with food enzymes

Suggested Readings [FQA-111] :

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.

Semester	**:**	**I**		
Course No.	**:**	**FQA-112**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**General Microbiology**		

SYLLABUS

Objectives:

(i) To identify the micro-organisms, their structure and growth characteristics and

(ii) To acquaint with techniques for cultivation and preservation and control.

THEORY

Scope and History of Microbiology: (Notable contributions of Leeuwenhoek, Pasteur, Koch, etc.). Place of Microorganisms in Living World; Groups of Microorganisms; Applied area of Microbiology. Classification and Identification of microorganisms; Major Characteristics of Microorganisms, Methods of classification of bacteria. Microscopy: Introduction to microscope; Component of microscope; Types of microscope and Microscopic techniques. Microbial Ultrastructure and Functions: Morphological features; Structures external to cell wall, Cell wall; Structures internal to cell wall. Cultivation and Preservation of microorganisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for microorganisms. Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: Growth curve, Continuous culture, Synchronous culture; Methods of isolation of pure cultures; Maintenance and Preservation of pure cultures; Culture collections. Control of microorganisms: Physical and Chemical agents. Bacterial Genetics. Structure and Functions of DNA and RNA; Overview of replication and regulation.

PRACTICAL

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.

TEACHING SCHEDULE

THEORY [FQA-112]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1-2	Scope and History of Microbiology	Notable Contributions of Leeuwenhoek, Pasteur, Koch, Edward Jenner, Ignaz Semmelweis, Louis Pasteur Joseph Lister, Paul Ehrlich, Alexander Fleming, etc. in Microbiology. Scope and economic importance of microorganisms, Applied area of Microbiology: Industrial Microbiology, Aquatic and Marine Microbiology, Public health Microbiology, Immunology, Food and Dairy Microbiology.	5
3-4	Place of Microorganisms in Living World;	Overview of the major groups of microorganisms, Role of Microorganisms in Ecosystem and Human Health, Ecosystem: Nutrient cycling, Organic matter decay, Pollution remediation, Climate change Human Health: Digestion, Immune system, Detoxification, Protection, Reproductive health.	5
5-10	Classification and Identification of Microorganisms	Microbial classification, Nomenclature and Identification; Taxonomic groups; General-, Methods of classifying bacteria; Major Characteristics of microorganisms: Cell types (Prokaryotic and Eukaryotic) and Presence of nuclear membrane; Methods of classification of bacteria: Gram stain, Shape, Cell wall composition, Respiration and Nutrition; Other methods for classifying microbes include: Differential staining, Biochemical testing, DNA fingerprinting or DNA base composition, Polymerase Chain Reaction and DNA Chips.	10
11-14	Microscopy	Microscopy and Microscopes: Principles, Simple and Compound microscopes, Phase. i) Introduction to microscope; ii) Types of microscopes: Optical microscopes, Electron microscopes, Scanning probe microscopes, Atomic force microscopes (AFMs), iii) Components of microscope: iv)Microscopic Techniques: Fluorescent microscopy, Electron microscopy (SEM and TEM), Applications, Smears and Staining	10

Continued…

15-17	Microbial Ultrastructure and Functions:	General structure of Prokaryotic and Eukaryotic Cells, Cell wall, Plasma membrane, Protoplasm, Endoplasmic reticulum, Lysosome, Golgi apparatus, Centriole, Cilia, Flagellum, Storage bodies, Ribosomes, Chloroplasts, Mitochondria and Nucleus. Morphology and Fine Structure of Bacteria, Size, Shape, Arrangement and Bacterial structures: Flagella, Pili, Capsule, Sheaths and Stalks.	10
18-21	Cultivation and Preservation of Microorganisms:	Cultivation of Bacteria, Nutritional requirements; Nutritional classification of Bacteria; Phototrophs, Chemotrophs, Autotrophs and Heterotrophs; Obligate parasites. Bacteriological media, Types of media and Physical conditions required for growth, Reproduction of Bacteria- Binary fission, budding. Maintenance and preservation of pure cultures; Methods of isolation of pure cultures: Streak plate, Pour plate and Spin plate methods; Growing the culture, Preserving in glycerol, Cryopreservation, Lyophilization, Maintenance media; Culture collections: Preservation, Distribution, Catalogues.	13
22-25	Bacterial Metabolism and Growth	i) Reproduction of Bacteria: Binary fission, Other Asexual reproduction methods, Genetic recombination, Factors affecting reproduction, Reproduction in different species, Sexual reproduction. ii) Growth of bacteria: Growth curve and phases; Continuous culture: Chemostat, Turbidostat, Perfusion Synchronous culture: Cell synchronization, Growth Kinetics, Quantitative measurement of bacterial growth; Recombination machinery, Meiotic recombination.	12
26-30	Control of Microorganisms	i) Physical agents: Temperature, Radiation, Other energies; ii) Chemical agents: Disinfectants, Antiseptics, Antibiotics, Chemotherapeutic antimicrobial chemicals.	15
31	Bacterial Genetics	Bacterial recombination; Mutation; Gene transfer, Transduction, Homologous recombination, Plasmids, Conjugation, DNA replication.	10
32	Structure and Functions of DNA and RNA	Overview of Replication and Regulation, Structure, Function, Sugar, Bases, Nucleotides, Nitrogen bases and Types of RNA.	10
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [FQA-112]

Exercise No.	Exercise Title
1	Experiment on Microscopy
2	Experiment on Micrometry
3	Cleaning and sterilization of glassware and acquainting with equipment used in Microbiology
4	Preparation of nutrient agar media and techniques of inoculation
5	Staining methods: Study on Monochrome staining
6	Staining methods: Study on Gram staining, negative staining
7	Staining methods: Study on Capsule-staining
8	Staining methods: Study on Flagella staining
9	Staining methods: Study on Endospore staining
10	Pure culture techniques (Streak plate)
11	Pure culture techniques (Pour plate)
12	Pure culture techniques (Spread plate)
13	Identification procedures (Morphology and Cultural characteristics)
14	Growth characteristics of bacteria: Determination of microbial numbers, direct plate count.
15	Generation time; Factors influencing growth: Effect of pH on growth curves for bacteria.
16	Generation time; Factors influencing growth: Effect of temperature on growth curves for bacteria.

Suggested Readings [FQA-112]:

1. **Pelczar Jr., M.J., Chan, E.C.S. and Krieg, N.R. 1998.** Microbiology. 5thedn. Tata McGraw-Hill Education, New Delhi.
2. **Tortora, G.J., Funke, B.R. and Case, C.L. 2014.** Microbiology: An Introduction. 12thedn. 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.

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Semester	**:**	**I**	
Course No.	**:**	**FE-111**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Post Harvest Engineering**	

SYLLABUS

Objectives: (i) To understand the basic post-harvest operations,

(ii) To gain an understanding of various engineering properties and

(iii) To differentiate between different types of material handling systems.

THEORY

Overview of Post-Harvest Technology. Concept and Science, Introduction to different Agricultural crops, their Cropping pattern, Production, Harvesting and Post-harvest losses, Reasons for losses, Importance of loss reduction, Post-Harvest Handling operations. Water Activity; Water binding and its effect on Enzymatic and Non-enzymatic reactions and Food texture, Control of water activity and Moisture. Engineering Properties of Food Materials; Physical, Thermal, Aerodynamic, Optical, Mechanical, Rheological and Electromagnetic properties and their measurement. Cleaning; Cleaning of grains, Washing of fruits and Vegetables, Types of cleaners, Screens, Types of screens, Rotary screens, Vibrating screens, Machinery for cleaning of fruits and vegetables (air cleaners, washers), Cleaning efficiency, Care and Maintenance; Peeling. Sorting, Grading, Methods of grading; Grading- Size grading, Colour grading, Specific gravity grading; Screening, Equipment for grading of fruits and vegetables, Grading efficiency, Care and Maintenance. Magnetic separator, Destoners, Electrostatic separators, Pneumatic separator. Decorticating and Shelling; Principles of working, Design and Constructional details, Operating parameters, Maintenance, etc. of various decorticators/dehullers/shellers, Description of groundnut decorticators, maize shellers, etc. Milling, Polishing, Grinding, Milling equipment, De-huskers, Polishers (abrasion, friction, water jet), Flour milling machines, Pulse milling machines, Grinders, Cutting machines, Oil expellers, Machine efficiency and Power requirement. Materials handling; Introduction to different conveying equipment used for handling of grains; Scope and Importance of material handling devices. Study of different Material Handling systems; Classification, Principles of operation, Conveyor system selection/design; Belt conveyor: Principle, Characteristics, Design, Relationship between belt speed and width, Capacity, Inclined belt conveyors, Idler spacing, Belt tension, Drive tension, Belt tripper; Chain conveyor: Principle of operation, Advantages, Disadvantages, Capacity and Speed, Conveying chain; Screw conveyor: Principle of operation, Capacity, power, Troughs, Loading and Discharge, Inclined and Vertical screw conveyors; Bucket elevator: Principle, Classification, Operation, Advantages, Disadvantages, Capacity, Speed, Bucket pickup, Bucket discharge, Relationship between belt speed, Pickup and Bucket discharge, Buckets types, Power requirement; Pneumatic conveying system: Types, Air/Product separators; Gravity conveyor design considerations, Capacity and Power requirement.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FE-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-2	Overview of Post-Harvest Technology	Definition and Overview of Post-Harvest Technology/ Engineering	5
3-5	Concept and Science	Introduction to different agricultural crops, Cropping Pattern, Production, Post harvesting and Post-harvest losses, Reasons for losses, Importance of loss reduction, Post-harvest handling operations.	10
6-8	Water Activity	Water binding, Effects on enzymatic and Non-enzymatic reactions and Food texture, Control of water activity and moisture.	10
9-14	Engineering Properties of Food Materials	Physical, Thermal, Aerodynamic, Optical, Mechanical, Rheological and Electromagnetic properties and their measurement.	10
15-16	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.	10
17-20	Sorting, Grading and Methods of grading	Size grading, Colour grading, Specific gravity grading; Screening, equipment for grading of fruits and vegetables, Grading efficiency, Care and maintenance, Magnetic Seperator, Destoners, Electrostatic separators, Pneumatic separator	15

Continued…

21-23	Decorticating and Shelling	Working Principle, Design and Constructional details, Operating parameters, Maintenance of various decorticators/ dehullers/ shellers, groundnut decorticators, Maize shellers etc.	10
24-26	Materials Handling	Different conveying equipments used for handling of grains; Scope and importance of material handling devices	10
27-32	Different Material Handling Systems	Classification, Principles of operation, Conveyor system selection/design; Belt conveyor: Principle, Characteristics, Design, Relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, Advantages, Disadvantages, Capacity and Speed, Conveying chain; Screw conveyor: Principle of operation, Capacity, Power, Troughs, Loading and Discharge, Inclined and Vertical screw conveyors; Bucket elevator: Principle, Classification, Operation, Advantages, Disadvantages, Capacity, Speed, Bucket pickup, Bucket discharge, Relationship between belt speed, pickup and bucket discharge; Buckets types, power requirement; Pneumatic conveying system: types, air/product separators; Gravity conveyor: design considerations, capacity and power requirement.	20
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-111]

Exercise No.	Exercise Title
1	Study of cleaners for grains
2	Study of washers for fruits and vegetables
3	Study of graders for grains
4	Study of graders for fruits and vegetables
5	Study of decorticators
6	Study of a maize/ sunflower sheller
7	Study of crop dryers
8	Study of a RF/MW/Tray dryer
9	Study of hot air dryer and modelling drying kinetics
10	Study of vacuum dryer and modelling drying kinetics
11	Study of working principle of spray dryer and spray drying process
12	Study of drum dryer and liquid food dehydration using drum drying
13	Study of fluidized bed dryer and drying process
14	Study of freeze dryer and freeze-drying process
15	Study of different materials handling equipment (Belt conveyors and Screw Conveyors)
16	Study of different materials handling equipment (Pneumatic conveyors)

Suggested Readings [FE-111]:

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.

List/ Bouquet of Skill Enhancement Courses (SECs)

Discipline/ Department	Sr. No.	Course No.	Course Title	Credits (Hrs.)
Food Technology	**1**	FT/SEC	Introduction to Drying Technology and Dryers	2(0+2)
	2	FT/SEC	Introduction to Processing of Extruded Foods	2(0+2)
	3	FT/SEC	Introduction to Milling (Rice, Dal, Spices, etc.)	2(0+2)
Food Quality Assurance	**1**	FQA/SEC	Introduction to Food Safety and Sanitation	2(0+2)
	2	FQA/SEC	Introduction to Good Laboratory Practices	2(0+2)
	3	FQA/SEC	Basic Food Analysis Laboratory Techniques	2(0+2)
Food Engineering	**1**	FE/SEC	Introduction to Electrical and Control Systems in Food Industry	2(0+2)
	2	FE/SEC	Introduction to Mechanical Systems in Food Industry	2(0+2)
	3	FE/SEC	Introduction to AutoCAD	2(0+2)
Food Plant Operations	**1**	FPO/SEC	Maintenance of Food Processing Equipment	2(0+2)
	2	FPO/SEC	Introduction to Bottling and Canning Line	2(0+2)
	3	FPO/SEC	Introduction to Manufacturing of Bakery Products	2(0+2)

Note : Skill Enhancement Courses can be added/offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject.

In case of unavailability of said detailed course-wise syllabus of above SEC courses, the same can be primarily developed and followed at College/ University level in the academic year, 2024-25; However, the same will be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

[Above list is an indicative list/bouquet of SEC courses and subject to modification as applicable therein]

Skill Enhancement Courses (SECs): Detailed Syllabi

Food Technology

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Drying Technology and Dryers**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1	Introduction to drying process and its mechanism
2	Understanding of different methods for moisture estimation
3	Determination of moisture content with oven method
4	Determination of drying characteristics and study of kinetics
5	Prediction of moisture sorption isotherms
6	Determination of equilibrium moisture content of grain
7	Introduction to different dryings theories and its importance
8	Introduction to different methods of drying (Contact, Convective and Radiation).
9	Principle and Operational mechanism involved in Cabinet and Tunnel Drying
10	Principle and Operational mechanism involved in Spray Drying
11	Principle and Operational mechanism involved in Roller/ Drum Drying
12	Principle and Operational mechanism involved in fluidized bed drying
13	Principle and Operational mechanism involved in foam-mat drying
14	Principle and Operational mechanism involved in microwave drying
15	Principle and Operational mechanism involved in vacuum oven drying
16	Principle and Operational mechanism involved in solar drying
17	Principle and Operational mechanism involved in refractance window drying of foods

18	Study of pretreatment methods for drying and dehydration
19	Study of operational principle and working of freeze dryer
20	Study of Rehydration/ Reconstitution properties of dehydrated foods
21	Drying of fruit slices in cabinet drier
22	Drying of green leafy vegetables
23	Drying of mango/ other pulp by foam-mat drying
24	Drying of foods using roller dryer and Spray dryer
25	Drying of foods using freeze drying process
26	Preparation of Mango Leather
27	Preparation of Osmo-Dehydrated Food Products (Candied Fruits, Glazed Fruits)
28	Preparation of dehydrated raisins
29	Study of packaging, labelling and FSSAI Regulations of Dehydrated products
30	Industrial Visit(s) to different dehydration Units
31	Case study on fruits and vegetable drying

Semester	**:**	**I**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Processing of Extruded Foods**		

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1	Introduction and market survey of extruded products
2	Introduction of food extruders components and their functions
3	Principle and operational mechanism involved in cold and hot extruder (Single and Twin-Screw Extruder)
4	Preparation of spaghetti pasta
5	Preparation of penne pasta
6	Preparation of noodles
7	Preparation of vermicelli
8	Preparation of instant noodles
9	Quality evaluation of pasta products
10	Demonstration of extrusion products (extruded snacks/ breakfast cereal/ texturized vegetable protein)
11	Preparation of traditional extruded products (sev/ chakli)
12	Evaluation of physical properties of expanded snacks
13	Evaluation of water and milk hydration properties of breakfast cereal
14	Evaluation of functional properties of expanded snacks
15	Evaluation of functional properties of texturized vegetable protein
16	Preparation of plant-based meat analogue by using extruder
17	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking
18	Preparation of extruded confectionary product
19	Effect of feed moisture content on extrudate food product characteristic
20	Studies on development of weaning food by extrusion technology
21	Texture profile analysis of extruded product

22	Preparation of dietary fiber rich extruded product
23	Quality evaluation of commercially available extruded food products
24	Packaging of Extruded products
25	Quality evaluation of different extruded products
26	Determination of techno-economic feasibility of prepared extruded product
27	Sensory evaluation of prepared extruded products
28	Labelling and FSSAI Regulations of different extruded products
29-30	Visit to Commercial Extrusion Unit

Semester	**:**	**I**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Milling (Rice, Dal, Spices, etc.)**		

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1	Introduction and market survey of milled rice, dal and spices
2	Determination of Physical Properties of rice grain, dal and spices
3	To study the defects in grains and milled rice, dal and spices by physical observation
4	Determination of moisture content in different milled product
5	Studies on traditional methods of milling of dal and rice grains
6	Cleaning of rice, dal and spices for milling
7	Studies on different dehusking and deshelling equipments involved in the milling of paddy grains
8	Principles and Operational mechanism of rice mills
9	Determination of Head Rice Yield (HRY), Milled Rice Yield (MRY) and % Brokens
10	Determination of polishing quality of paddy
11	Studies on different by-products of paddy milling
12	Studies on different methods and pretreatments involved in pulse milling
13	Studies on Dry milling and Wet milling of pulses for production of dal
14	Principles and Operational mechanism of Dal Mills
15	Cleaning and inspection for effective grading and sieving of grains based on size and grade
16	Demonstration of the procedure of cleaning of unprocessed whole spices
17	Principles and Operational mechanism of Spice Mills
18	Manufacture of Dalia from cereals and legumes

19	Production process of rice from paddy
20	Study on Mini Dal Mill
21	Studies on utilization of by-products from dal milling industry
22	Preparation of turmeric powder
23	Preparation of curry powder
24	Recipe formulation and preparation of different spice mix powders (Turmeric, Chilli, Onion, Ginger etc.)
25	Sieve analysis of milled products for particle size distribution
26	Milling yield calculation for different grains
27	Packaging and storage techniques for milled products
28	Techno-economic feasibility of prepared spice powder and milled dal
29	Case study on spice powder processing industries
30	To study milling quality of rice, dal and spices
31	Study of packaging, labelling and FSSAI Regulations of Dehydrated products
32	Visit to Commercial Rice mill, Dal mill and Spice industry.

Food Quality Assurance

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Food Safety and Sanitation**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Understanding Food Safety and Sanitation: Concept, Terms and Importance
3-4	Developing the process flow for the food establishment including all the inputs, outputs and interim loops
5-6	Data collection for identification of biological, chemical and physical hazards
7-8	Hazard Analysis using FMEA Technique for Risk Assessment
8	Demonstration of Correct method of washing hands
9	Assessment of personal hygiene
10-11	Identifying the Key Focus Areas for GHP and GMP
12-13	Identifying Gaps in its Implementation; Closure Plans for Identified Gaps
14-15	Importance of temperature control and Demonstrating proper cooking, cooling and reheating temperatures using thermometers
16-17	Introduction to HACCP
18-19	Development of OPRP (Operational Pre-requisite Programme) and Development of HACCP Plan (Critical Limits including Rationale for Limits)
20-21	Monitoring Procedure, Correction and Corrective Measures
22-23	Introduction to Cleaning agents and Techniques for Sanitizing surfaces
24-25	Hands-on Demonstration of using Chemical Sanitizers correctly
26-27	To recognize signs of pest infestations and methods of control
28-29	Demonstration of segregation of waste
30-31	To study proper disposal methods for different types of waste
31-32	Practice identifying common food allergens and labelling

Semester	**:**	**I**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Good Laboratory Practice**		

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Introduction and Importance of Good Laboratory Practices
3-4	Practical session on identifying hazards and using appropriate Personal Protective Equipment
5-6	Hands-on practice with common lab equipment (e.g., microscopes, pipettes, balances, centrifuges etc.)
7-8	Equipment calibration techniques and How to properly maintain instruments
9-10	Techniques for cleaning, drying and sterilizing lab glassware to prevent contamination
11-12	Autoclave operation for Sterilization, Calibration of balances, pH meters and Spectrophotometers
13-14	Sample collection techniques for biological, chemical, or environmental samples
15-16	Correct labelling and storage procedures to maintain integrity
17-18	Proper segregation and disposal of hazardous and non-hazardous lab waste
19-20	Understanding chemical compatibility and safe disposal practices
21-22	Performing basic quality control tests like titration, pH measurement and UV-Vis Spectrophotometry to assess the purity and quality of samples
23-25	Aseptic techniques for handling microbial cultures, preparing agar plates and transferring cultures
26-28	Detecting, recording and reporting errors or deviations in experimental work
29-30	Writing and following SOPs for basic lab techniques like, solution preparation or instrument usage

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Basic Food Analysis Laboratory Techniques**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Sampling plan; Sample collection and preparation for analysis
3-4	Sensory evaluation techniques of food products
5-6	Quality evaluation of food products for color and taste of marketed products
7-8	Determination of moisture content in food samples
9-10	Water analysis
11-12	Determination of ash content in food samples
12-13	Determination of crude fat in food samples
14-15	Determination of crude protein in food samples by Kjeldahl method
15-16	Determination of crude fibre in food samples
17	Qualitative tests for sugars
18-19	Qualitative tests for proteins, Colorimetric estimation of protein concentration
20-21	Estimation of total and reducing sugars
22-23	Measuring the pH of various food samples like fruits, dairy, and beverages
24-25	Determining the acidity in food samples by titrating with a base
26-27	Determination of Total Soluble Solids and Vitamin C in food samples
28	Determination of Salt Content in food samples
29-30	Estimation of chlorophyll and carotenoids in food samples
31	Estimation of Macro and Micro Minerals
32	Visit to NABL-Accredited Food Laboratory

Food Engineering

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Electrical and Control Systems in Food Industry**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Build simple electrical circuits using resistors, capacitors and inductors
3	Measurement of voltage, current and resistance using a multimeter
4-5	Explore different types of sensors used in food processing
6-7	Performing calibration exercises with EC/ pH meter. Study of different types of motors (AC, DC, Stepper) and their applications
8-9	Developing a motor control circuit for a conveyor system
10-11	Programming simple control sequences using PLC software
12	Creating a basic ladder logic diagram for a conveyor belt system
13	Simulating PID control for a temperature control system
14-15	Designing a simple HMI using software tools (like Factory Talk or Win CC)
16-17	Integrating the HMI with PLC for monitoring and control
18-19	Setting-up a small SCADA system for monitoring a food processing operation
20-21	Understanding data logging and visualization techniques
22	Learning about industrial communication protocols (Modbus, Ethernet/IP)
23	Creating a simple network setup to connect PLCs and HMIs
25	Building and analyze a control loop for a food processing scenario (e.g. Pasteurization)
26	Understanding feedback mechanisms and their importance in control systems
27	To diagnose and troubleshoot faulty electrical circuits
28	To develop systematic approaches to identify common issues
29	To measure and analyze energy consumption in a small-scale food processing set-up
30	To explore energy-saving practices and technologies in the industry
31	Safety Protocols in Electrical Systems
32	Visit of food industry for practical exposure of electrical and control system

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Mechanical Systems in Food Industry**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Introduction to mechanical system and its application in food industry
3-4	To identify and understand the function of basic mechanical components (gears, belts, pulleys, bearings) used in food machinery
5-6	To study different materials used in food machinery and their properties
7-8	To practice the assembly and disassembly of simple food processing machines (e.g., mixers, blenders)
9-10	To measure and analyze vibration in food processing equipment
11-12	To learn how to identify issues such as misalignment or imbalance
13-14	To perform routine maintenance tasks on mechanical systems (lubrication, belt tensioning)
15-16	To conduct troubleshooting exercises to identify and fix common mechanical failures
17	Study of principles, construction and working of Cleaning equipments
18	Study of principles, construction and working of Sorting/grading equipments
19	Study of principles, construction and working of Washing equipments
20	Study of principles, construction and working of Handling equipments
21	Study of principles, construction and working of Food packaging machines
22-23	To conduct tests to evaluate corrosion resistance and suitability for food contact
24-25	To explore the use of robotic systems for tasks such as packing or palletizing
26-27	To implement quality control measures in a mechanical process (e.g., measuring dimensions of food products)
28-29	To create basic mechanical drawings using CAD software
30-31	Project work to enlist various mechanical parts and its functionality in different food processing industries
32	Visit of Food Industry to identify mechanical systems in food processing

Semester	**:**	**I**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to AutoCAD**		

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Introduction to AutoCAD and its application in the food processing industry
3-4	Familiarization with the AutoCAD interface: toolbars, menus, and command line
4-5	Practice using drawing tools to create geometric shapes
6-7	Experiment with drawing precision using grid and snap features
8	Learning to modify objects using commands such as move, copy, rotate, scale and mirror
9	To perform exercises on editing shapes and lines in an existing drawing
10	To create and manage layers in a drawing
11	To assign different colours and line types to layers for better organization
12	To add linear, radial and angular dimensions to drawings
13-14	To practice dimensioning techniques and understand best practices for clarity
15	To insert text and annotations into a drawing
16	To explore styles and formatting options for clarity and presentation
17-18	To draw a complete 2D engineering drawing of an equipment
19	Introduction to 3D modelling: create basic 3D shapes (cubes, cylinders)
20-21	To practice using 3D viewing tools and rendering techniques
22-23	Setting-up a layout for printing: scaling, title blocks and viewports
24-25	Understanding the file types and compatibility issues (DWG, DXF) to save the AutoCAD files
26	To attach and manage external references in a drawing
27-28	To develop a detailed plan (floor plan, mechanical part) incorporating multiple elements
29-30	To create isometric drawings to represent three-dimensional objects in two dimensions
31-32	To practice isometric dimensioning and labeling

Food Plant Operations

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Maintenance of Food Processing Equipment**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Hands-on identification of various types of food processing equipment
3-4	Creation of customized preventive maintenance checklists for different equipment
5-6	Simulated execution of a preventive maintenance routine
7	Understanding the types of lubricants used in food processing
8	Practicing proper lubrication techniques on machinery
9-10	Learning about different cleaning agents and their appropriate use
11-12	Conducting cleaning protocols on equipment in compliance with food safety standards
13-14	Practical exercises in electrical troubleshooting, including circuit testing and voltage measurement
15-16	Dismantling and reassembling parts of common food processing equipment
17-18	Simulated troubleshooting of common equipment malfunctions
19-20	Simulating the documentation of maintenance activities and creating maintenance logs
21	Study of maintenance of cleaning equipment
22-23	Study of care and maintenance of Sorting/Grading equipment
24-25	Study of care and maintenance of Milling equipment
26-27	Study of and care and maintenance of Drying equipment
28-29	Study of care and maintenance of Material Handling equipment
30-31	Study of care and maintenance of Packaging equipment
32	Study of care and maintenance of Storage units

Semester	**:**	**I**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Bottling and Canning Line**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title
1-2	Introduction to bottling and canning process
3	Study of sorting and grading equipments
4	Study of washing equipments
5	Study of peeling methods and equipments
6	Study of cutting equipments
7	To perform the blanching of fruits and vegetables
8	To check the adequacy of blanching process
9-10	Study of different types of bottles and cans, including materials and sizes
11	Study of different filling techniques (gravity, pressure, vacuum)
12	Practical session on filling bottles/cans accurately
13	Cutout analysis of cans
14	Hands-on practice on in-bottle sterilization
15	Hands-on practice with various sealing methods (screw caps, corks, can lids)
16	Testing seal integrity using various methods
17	Practical session on labeling machinery operation
18	Coding and printing best practices for product information
19	Conduct quality checks on filled and sealed products
20	Discuss common quality issues and troubleshooting techniques
21	Study of domestic carbonator and carbonation process
22	Learn proper cleaning and sanitation protocols for equipment
23-24	Hands-on cleaning sessions for different parts of the line
25	Basic maintenance tasks for key equipments
26	Troubleshooting common problems in bottling and canning lines
27	Workshop on regulations affecting bottling and canning
28	Product Handling and Storage
29	Practical session on proper storage techniques
30-31	Study of packaging, labelling and FSSAI Regulations of beverages and canned products
32	Visit to Beverage and Canning Industry

Semester	**:**	**I**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Manufacturing of Bakery Products**		

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic
1-2	Introduction and market survey of bakery products
3-4	Study of different methods of preparation of bakery product (Bread, Biscuit, Cake and Cookies etc.)
5-6	Determination of Gluten Content in wheat flour
7-8	Determination of Sedimentation value of wheat flour
9-10	Determination of Pelshenke value of wheat flour
11-12	Determination of water and oil absorption of flour
13-14	Determination of emulsion capacity and stability of flour
15-16	Determination of foaming capacity and stability of flour
17-18	Determination of alkaline water retention capacity of flour
19-20	Preparation and quality evaluation of composite formulation of wheat-based cookies
21-22	Preparation and quality evaluation of millet-based cookie formulations
23-24	Preparation and quality evaluation of crackers
25-26	Preparation and quality evaluation of unleavened flat breads
27-28	Preparation and quality evaluation of leavened breads (White bread, Brown Bread)
29	Preparation and quality evaluation of cake/muffin
30	Preparation and quality evaluation of baked cereal bar
31	Study of packaging, labelling and FSSAI Regulations of bakery products
32	Visit a Commercial Bakery Unit

Course Curriculum of Second Semester as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in

FOOD TECHNOLOGY

- UG-Certificate in Food Technology
- UG-Diploma in Food Technology
- UG-Degree: B.Tech. (Food Technology)

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Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Layout

B.Tech. (Food Technology)

Semester: II (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark (if any)
1.	**AEC-123**	National Service Scheme (NSS-II)/ National Cadet Corps (NCC-II)	1(0+1)	--
2.	**VAC-121**	Environmental Studies and Disaster Management	3(2+1)	--
3.	**FQA-123**	Design and Formulation of Foods	3(2+1)	--
4.	**FE-122**	Waste and By-products Utilization	3(2+1)	--
5.	**FE-123**	Engineering Drawing and Graphics	3(1+2)	--
6.	**FE-124**	Food Thermodynamics	3(2+1)	--
7.	**FE-125**	Unit Operations in Food Processing	3(2+1)	--
8.	**SEC-123**	Skill Enhancement Course-III[#] (*To be offered from the list of SEC Courses*)	2(0+2)	--
9.	**SEC-124**	Skill Enhancement Course-IV[#] (*To be offered from the list of SEC Courses*)	2(0+2)	--
		Total Credits Hrs.	**23(11+12)**	**G**
AEC: Ability Enhancement Course, **MDC**: Multidisciplinary Course, **SEC**: Skill Enhancement Course, **VAC**: Value Added Course, **G**: Gradial				
Post-II Semester (Only for Exit option for award of UG-Certificate*)				
10.	**INT-121**	Internship (10 Weeks)	10(0+10)	--

Note: Students taking various SKILL ENHANCEMENT COURSES will be eligible to get a UG-Certificate with Nomenclature as follows, provided the student has to select courses as mentioned against the nomenclature of the UG-Certificate.

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

In case a student wishes to exit at this point,

***Select any two of following courses from the bouquet of Skill Enhancement Courses (SEC) from the discipline of Food Plant Operations (FPO) in Second semester:**

i) Maintenance of Food processing Equipment
ii) Introduction to Bottling and Canning Line
iii) Introduction to Manufacturing of Bakery Product

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**II**	
Course No.	**:**	**AEC-123**	**Credit Hrs. : 1 (0+1)**
Course Title	**:**	**National Service Scheme-II (NSS-II)/ National Cadet Corps-II (NCC-II)**	
Gradial Common Course across all UG Degrees			

Course No.: AEC-123	**Course Title: National Service Scheme-II (NSS-II)**	**Credit Hrs.: 1(0+1)**

SYLLABUS

Objectives :

(i) To evoke social consciousness among students through various activities viz., working together, constructive and creative social work,

(ii) To be skillful in executing democratic leadership, developing skill in program,

(iii) To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

PRACTICAL

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

TEACHING SCHEDULE

PRACTICAL [AEC-123/ NSS-II]

Exercise No.	Title	Sub-topics/ Key points
1	**Orientation on NSS**	Introduction to NSS, its Objectives, History and Role in community service.
2	**Youth Leadership**	Discuss the importance and role of youth leadership, types and traits of leadership and qualities of good leaders.
3	**Life Competencies**	Understanding life competencies, their importance and Practical exercises in problem-solving and decision-making.
4	**Interpersonal Communication**	Practice exercises to improve interpersonal communication skills, Focusing on active listening and effective communication.
5	**Youth Development Programs**	Overview of youth development programs, Policies at national and state levels and Understanding youth-led organizations.
6	**Health, Hygiene, and Sanitation**	Practical activities on the importance of hygiene and sanitation, including Swachh Bharat Abhiyan tasks.
7	**Nutrition and Health Education**	Discuss the role of food, nutrition, and safe drinking water in health; Explore the impact of waterborne diseases.
8	**National Health Programs**	Introduction to key national health programs and their roles in promoting public health and awareness on reproductive health.
9	**Youth Health and Lifestyle**	Sessions on healthy lifestyle choices including exercise, balanced diet and stress management.
10	**HIV/AIDS Awareness**	Educational activities on HIV/AIDS, its prevention, and reducing stigma; Awareness on reproductive health.
11	**Substance Abuse Awareness**	Discussing the dangers of drug and substance abuse, its impact on health and practical ways to prevent addiction.
12	**First Aid and Home Nursing**	Hands-on training in first aid techniques including handling injuries, CPR basics and home nursing care.
13	**Introduction to Yoga**	Introduction to the History, Philosophy and various Traditions of Yoga as a Holistic health practice.
14	**Yoga Practice**	Practical Yoga Sessions focusing on Asanas, Pranayama and Meditation for a healthy lifestyle.
15	**Yoga as Preventive and Curative Tool**	Understanding and Practicing Yoga as a preventive and curative approach for physical and mental health.
16	**Reflection on NSS and Youth Development**	Group Discussion and Reflection on the role of NSS in community building and personal growth, Focusing on youth leadership.

Course No.: AEC-123	Course Title: National Cadet Corps-II (NCC-II)	Credit Hrs.: 1(0+1)

SYLLABUS

Objectives :

i. 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,

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

PRACTICAL

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

TEACHING SCHEDULE

PRACTICAL (AEC-123/ NCC-II)

Exercise No.	Title	Sub-topics
1	**Basic Arms Drill**	Attention, stand at ease, stand easy, getting on parade, dismissing and falling out.
2	**Advanced Arms Drill**	Ground/take up arms, examine arms, shoulder from the order and vice versa.
3	**Saluting with Arms**	Saluting at the shoulder both at a halt and while on the march.
4	**Rifle Handling Techniques**	Short/long trail from the order and vice versa, guard mounting and guard of honor procedures.
5	**Platoon and Company Drill**	Practice and demonstration of platoon and company drill formations.
6	**Rifle Characteristics and Handling**	Characteristics of rifles (.22/.303/SLR), ammunition, firepower, and basic care, cleaning, and sight setting.
7	**Rifle Operations and Safety**	Loading, cocking, unloading, safety procedures; lying position, trigger control, and firing a shot.
8	**Range Procedures and Target Practice**	Range procedures, aiming, sight alteration, theory of groups, snap shooting, and firing at moving targets.
9	**Map Reading Basics**	Introduction to maps, scales, conventional signs, topographical forms, and the grid system.
10	**Advanced Map Skills**	Relief, contours, gradients, cardinal points, bearings, and use of the service protractor.
11	**Field Navigation with Compass**	Use of prismatic compass, setting a map, finding north, positioning, map-to-ground, and ground-to-map.
12	**Field Engineering Skills**	Knots and lashings, camouflage, handling explosives, IEDs, field defenses, obstacles, and mines.
13	**Water man ship and Field Water Supplies**	Bridging techniques, field water supplies, track construction, and distance judgment.
14	**Target Recognition and Indication**	Identifying and describing targets, observing, concealment, field signals, and indication of landmarks.
15	**Section Battle Drills and Movement**	Section formations, fire control orders, fire and movement, movement with/without arms, section battle drill.
16	**Communication Skills and Modern Trends**	Types of communication, media and latest trends in NCC communication.

Semester	**:**	**II**	
Course No.	**:**	**VAC-121**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Environmental Studies and Disaster Management**	
Gradial Common Course across all UG Degrees			

SYLLABUS

Objectives : (i) To expose and acquire the knowledge on the environment,
(ii) To gain the state-of-the-art skill and expertise on management of disasters.

THEORY

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

Environmental Pollution: Definition, Cause, Effects and Control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, Effects and Control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, Rain water harvesting, Watershed management. Environmental Ethics: Issues and possible solutions, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and Holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and Human Health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and Human health.

Disaster Management - Disaster: Definition-Types-Natural Disasters: Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, National disaster management framework; Financial arrangements; Role of NGOs, Community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed Forces in disaster response; Police and other organizations in disaster management.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [VAC-121]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction to Environmental Studies	Definition, Scope and Importance; Multidisciplinary nature	4
2	Segments of Environment	Spheres of Earth – Lithosphere, Hydrosphere, Atmosphere and Different Layers of Atmosphere.	4
3 - 5	Natural Resources	Classification of resources; Forest, water, mineral, food, energy, land, and soil resources	10
6 - 7	Concept of an Ecosystem	Concept, Structure, Function and Energy flow in ecosystems	5
8 - 9	Types of Ecosystems	Terrestrial, Aquatic, Agroecosystems, Forest ecosystems and Human-modified ecosystems	5
10 - 12	Biodiversity and its Conservation	Importance, Value, Types, Biogeographical classification, Hotspots, Threats, Conservation strategies	8
13 - 16	Environmental Pollution	Definition, Causes, Effects, Control measures: Air, Water, Soil, Marine, Noise, Thermal and Light pollution	12
17 - 18	Solid Waste Management	Classification of solid wastes; Management methods like, Composting, Incineration, Pyrolysis, Biogas production	6
19	Urban and Industrial waste	Causes, Effects and Control measures of Urban and Industrial waste	4
20	Social Issues Related to the Environment	Urban energy problems, Water conservation, Rainwater harvesting, Watershed management	4
21 - 22	Environmental Ethics	Issues, Possible solutions, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and Holocaust.	6

Continued…

23	Environment Protection Laws	Environment Protection Act, Air and Water (Pollution) Acts, Wildlife Protection Act, Forest Conservation Act	4
24 - 25	Human Population and Environment	Environment and human health, Human rights, Value education, Women and child welfare, Role of IT in environment and health	5
26 - 28	Introduction to Disaster Management	Definition, Types of natural and man-made disasters; Floods, Droughts, Cyclones, Earthquakes, Landslides, Fires	10
29 - 30	Disaster Management Framework	National and International strategies, disaster response framework, Financial arrangements, Role of NGOs and media	5
31	Central and Local Administration in Disasters	Role of Central, State, District and Local Administrations; Coordination in disaster response	4
32	Disaster Response Organizations	Central, State, District and Local Administrations in Disaster Control; Role of Armed Forces, Police and Other organizations in disaster response and control	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [VAC-121]

Exercise No.	Exercise Title
1	Visit to a local area to document environmental assets: River/Forest/Grassland/Hill/Mountain.
2	Visit to Biogas production, Windmill, Hydro/Solar power generation units
3	To assess floral and faunal diversity in farming systems.
4	Assessment of biodiversity in farming system.
5	Floral and faunal diversity assessment in polluted and unpolluted system.
6	Visit to Local Polluted Site - Urban/Rural/Industrial/Agricultural to study the common plants, insects and birds. Environmental sampling and preservation.
7	Water quality analysis: pH and electrical conductivity (EC) in water samples.
8	Estimation of total dissolved solids (TDS) in water samples
9	Estimation of acidity and alkalinity in water samples.
10	Estimation of water hardness in water samples.
11	Determination of dissolved oxygen (DO) and biological oxygen demand (BOD) in water samples.
12	Performing COD estimation on water samples.
13	Enumeration of *E. coli* in water samples to check for contamination.
14	Assessment of Suspended Particulate Matter (SPM) in an environmental sample.
15	Study of simple ecosystem -Visit to Pond/River/Hills.
16	Visit to areas affected by natural disaster.

Suggested Readings (VAC-121):

1. **De, A.K. 2010.** Environmental Chemistry. Published by New Age International Publishers, New Delhi. ISBN:139788122426175. 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), Bangaluru. 36 pp.
3. **Erach Bharucha,** Text Book for Environmental Studies. University Grants Commission, New Delhi.
4. **Parthiban, K.T., Vennila, S., Prasanthrajan, M. and Umesh Kanna, S. 2023.** Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. **Prasanthrajan, M. and Mahendran, P.P. 2008.** A Text Book on Ecology and Environmental Science.1st Edn. ISBN 8183211046. Agrotech Publishing Academy, Udaipur - 313 002.
6. **Prasanthrajan, M. 2018.** Objective Environmental Studies and Disaster Management, ISBN 9789387893825. Scientific Publishers, Jodhpur, India. 146 pp.
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.

Semester	**:**	**II**			
Course No.	**:**	**FQA-123**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Design and Formulation of Foods**			

SYLLABUS

Objectives: (i) To understand about RDA for Indians,

(ii) To design and formulate new and innovative target foods,

(iii) To gain and apply knowledge about various therapeutic diets.

THEORY

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

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FQA-123]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-3	Introduction to Nutrients, Antinutrients and Food Classification	Nutrients and their functions, Food classification and their nutritive value, Anti-nutritional factors present in food	10
4-6	Food Groups and RDA	Concept of different food groups, Recommended dietary allowances (RDA) for Indians	10
7-9	Nutrition of Communities	Nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people	10
10-12	Indian Traditional Snack Foods	Production and formulation of Indian traditional sweet and snack food products, Steps for quality improvement and value addition.	10
13-17	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	15
18-20	Functional Food	Definition and Concepts; Design of Functional foods	10
21-23	Nutraceuticals Food	Definition and Concepts, Design of Nutraceutical foods	10
24-25	Recent Trends	Recent trends in Food Formulation	5
26-27	Antioxidant Rich Food Products	Antioxidant rich food products	5
28-30	Foods for Drought and Disaster	Concepts for formulation of foods for drought and disaster afflicted	10
31-32	Special Foods	Defence services, Sportsmen, Space food	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FQA 123]

Exercise No.	Exercise Title
1	To study the principles and planning menu
2	Develop diet plan using food exchange list
3	Nutrient calculation for school children
4	Nutrient calculation for adult and pregnant
5	Preparation and formulation of Indian Traditional Snack and Sweet
6	Preparation and development of food for pregnant women
7	Preparation and development of food for lactating women
8	Preparation of food for infants
9	Preparation and formulation of food and energy drinks for diabetic person (Sugar-free food products)
10	Preparation of prebiotic food product
11	Preparation of probiotic food product
12	Preparation of functional food using millets
13	Preparation of whey beverage
14	Production of functional beverages
15	Antioxidant activity of functional beverages
16	Visit to Food Processing Industries/ Expos

Suggested Readings [FQA-123]:

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 Dekk.

Semester	**:**	**II**	
Course No.	**:**	**FE-122**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Waste and By-products Utilization**	

SYLLABUS

Objectives:

(i) To understand the nature of agricultural wastes and their impact on the environment,

(ii) To conceptualize physical, chemical and biological basis of agricultural waste treatment,

(iii) To analyze & design systems for collection, handling, treatment and utilization of wastes,

(iv) To understand & apply the waste treatment processes.

THEORY

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from food industry, rice mill, sugarcane industry, oil mill etc. Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management-temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues. Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; biofuels and ethanol, packaging material through recycling. Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting. Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste-trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal. Assessment, treatment and disposal of solid waste; Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FE-122]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-2	Introduction	Types and formation of by-products and waste, Magnitude of waste generation in different food processing industries	10
3-4	Types of Different Agricultural By-products	Uses of different agricultural by-products from Food industry, Rice mill, Sugarcane industry, Oil mill	10
5-6	Concept, Scope and Maintenance	Concept, scope and maintenance of waste management and effluent treatment	5
7-10	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,	10
11-12	Microbiology of Waste	Microbiology of waste, Other ingredients like, insecticide, pesticides and fungicides residues.	5
13-16	Waste Utilization	Waste utilization in various industries, Furnaces and boilers run on agricultural wastes and by products, Briquetting of biomass as fuel, Production of charcoal briquette, Generation of electricity using surplus biomass, Producer gas generation and utilization; Biofuels and ethanol, Packaging material through recycling.	15
17-19	Waste Treatment and Disposal	Design, Construction, Operation and Management of institutional community and family size biogas plants, Vermi-composting.	10
20-21	Pre-treatment of Waste	Sedimentation, Coagulation, Flocculation and Floatation	5
22-24	Secondary Treatments of Effluents	Biological and Chemical Oxygen demand for different Food plant waste– trickling filters, Oxidation ditches, Activated sludge process, Rotating biological contractors, Lagoons	10
25-27	Tertiary Treatments of Effluents	Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal	10
28-30	Assessment, Treatment & Disposal of Solid Waste	Assessment, treatment and disposal of solid waste; Effluent treatment plants,	5
31-32	Compliance with ISO	Environmental performance of the Food Industry to comply with ISO-14001 standards	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-122]

Exercise No.	Exercise Title
1	Determination of temperature waste water
2	Determination of pH of waste water
3	Determination of turbidity of waste water
4	Determination of solid content of waste water
5	Determination of BOD (Biological Oxygen Demand) of waste water
6	Determination of COD (Chemical Oxygen Demand) of waste water
7	Determination of ash content of agricultural wastes
8	Determination of un-burnt carbon in ash
9	Study about briquetting of agricultural residues
10	Estimation of excess air for better combustion of briquettes
11	Study of extraction of oil from rice bran
12	Study of extraction of starch from mango kernel
13	Study on bioconversion of cereal grain based agricultural wastes
14	Study on bioconversion of fruit and vegetable based agricultural wastes
15	Recovery of germ and germ oil from by-products of cereals
16	Visit to various industries using waste and food by-products

Suggested Readings [FE-122]:

1. **Bhatia SC. 2001.** Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.
2. **Garg SK. 1998.** Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
3. **Joshi VK and Sharma S K. 2011.** Food Processing Waste Management: Treatment and Utilization Technology. New India Publishing Agency.
4. **Markel IA. 1981**. Managing Livestock Waste. AVI Publishing Co.
5. **Pantastico ECB. 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 RL and Prussi SE. 1992.** Post-Harvest Handling - A Systems approach. Academic Press Inc.
8. **USDA 1992.** Agricultural Waste Management Field Hand book. USDA, Washington DC.
9. **Weichmann J. 1987.** Post-Harvest Physiology of Vegetables. Marcel and Dekker Verlag.
10. **Vasso O and Winfried R (Eds). 2007.** Utilization of By-products and Treatment of Waste in the Food Industry. Springer Science and Business Media, LLC 233 New York.

Semester	**:**	**II**			
Course No.	**:**	**FE-123**	**Credit Hrs.**	**:**	**3(1+2)**
Course Title	**:**	**Engineering Drawing and Graphics**			

SYLLABUS

Objectives: (i) To gain an understanding about drawing as per engineering requirement
(ii) To have an idea of the isometric, orthographic views and projection
(iii) To gain knowledge about Computer-Aided Design

THEORY

Definition of Projection, Principle of projection, Methods of projections, Orthographic projection, plane of projection, First and third angle of projection. Different methods of dimensioning; Isometric scale, Isometric axes, Isometric projection, Preparation of working drawing from models and isometric views. Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints. Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Drawing of missing views. Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FE-123]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1	Introduction to Projections	Definition of Projection, Principle of Projection	5
2-3	Methods of projections	Orthographic projection, Plane of projection, First and third angle of projection	10
4-5	Dimensioning	Different methods of dimensioning; Isometric scale, Isometric axes, Isometric projection	10
6-7	Working Drawing	Preparation of working drawing from models and isometric views	10
8-9	Sectioning	Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts	15
10-11	Rivet Heads and Joints	Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints.	10
12-14	Threads, Nuts, Bolts and Screws	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.	20
15	Design and Graphics	Application of computers for design, definition of CAD, benefits of CAD,	10
16	CAD Components	CAD system components; Computer hardware for CAD	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-123]

Exercise No.	Exercise Title
1	Introduction of drawing scales
2	Principles of orthographic projections
3	References planes
4-5	Points and lines in space and traces of lines and planes
6-7	Auxiliary planes and true shapes of oblique plain surface
8-9	True length and inclination of lines
10	Projections of solids
11-12	Change of position method, alteration of ground lines
13-14	Section of solids and interpenetration of solid-surfaces
15-16	Development of surfaces of geometrical solids
17	Isometric projection of geometrical solids
18-19	Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components
20	Preparation of sectional drawings of simple machine parts
21	Drawing of riveted joints and thread fasteners
22-23	Demonstration on computer graphics and computer-aided drafting use of standard software
24-25	Sectional drawings of engineering machines
26-27	Computer graphics for food engineering applications
28-29	Interpretation of sectional views of food equipments and components
30	Practice in the use of basic and drawing commands on AutoCAD
31-32	Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

Suggested Readings [FE-123]:

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

Semester	**:**	**II**			
Course No.	**:**	**FE-124**	**Credits Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Food Thermodynamics**			

SYLLABUS

Objectives: (i) To have an idea about basic concepts of energy and laws of thermodynamics,

(ii) To gain knowledge about thermodynamic cycles and their application,

(iii) To gain knowledge about psychrometric properties of air and its application in drying and other food applications.

THEORY

Basic concepts: Definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat. First law of thermodynamics: Energy, enthalpy, specific heats, applications of First law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, Reversible and irreversible processes, entropy, availability and irreversibility. Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle. Psychometry: Thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms. Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity. Boilers and steam generation: Fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

PRACTICAL

Demonstration and application of Zeroth law of thermodynamics; First law of thermodynamics; and Second law of thermodynamics. Study of different types of boilers; Boiler mounting and accessories; Various types of burners and fuels; Determination of calorific values of different fuels. Study of vapour compression refrigeration test rig; Heat pump; Properties of wet, dry, saturated and superheated steam; Use of Steam tables and Moiler charts; Dryness fraction of steam; Use of psychometric chart for humidification, dehumidification, heating and drying; Determination of thermodynamic properties on psychrometric charts; Study of steam trap and steam line layouts; Visit to food plant with steam utilization.

TEACHING SCHEDULE

THEORY [FE-124]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Basic Concepts	Definitions, Approaches, Thermodynamic systems	5
2-3	Thermodynamic Properties	Thermodynamic properties and equilibrium, State of a system, State diagram, Path and process; Different modes of work	5
4	Law of Thermodynamic	Zeroth law of thermodynamics, Concept of Temperature, Heat	5
5	First Law of Thermodynamics	Energy, Enthalpy, Specific heats	5
6-7	Applications of First Law of Thermodynamics	Applications of First law, Steady and Unsteady flow analysis	5
8-10	Second Law of Thermodynamics	Kelvin-Planck and Clausius statements, Reversible and irreversible processes, Entropy, Availability and irreversibility.	5
11-12	Properties of Pure Substances	Thermodynamic properties of pure substances in solid, liquid and vapor phases	5
13-14	Behaviour of Substances	P-V-T behaviour of simple compressible substances, Phase rule	5
15-16	Thermodynamic Cycles	Carnot vapor power cycle, Ideal Rankine cycle, Air standard Otto cycle, Air standard Diesel cycle, Vapor-compression refrigeration cycle.	5
17-18	Psychometry	Thermodynamic properties of moist air, Perfect gas relationship, Absolute humidity, Relative humidity, Percentage humidity, Humid volume, Total heat, Enthalpy	5
19-20	Concept of Dry Bulb and Wet Bulb Temperature	Dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms	10

Continued….

21	Three Stages of Water	Phase diagram for water, Vapour pressure-temperature curve for water	5
22-23	Heat Requirement	Heat requirement for vaporization, Measurement of humidity	5
24	Boilers and Steam Generation	Fuels for boilers and steam generation	5
25-26	Boiler Types	Boiler types, Boiler mountings and Accessories	5
27-28	Boiler Regulation Act	Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints	5
29	Boiler Draught	Definition, Importance and Classification of draught, Natural and artificial draught	5
30	Draught Analysis	Calculation of height of chimney, Draught analysis	5
31-32	Properties of Steam and Steam Tables	Properties of steam; Wet, dry saturated, superheated steam, Use of steam tables.	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-124]

Exercise No.	Exercise Title
1	Demonstration and application of Zeroth law of thermodynamics
2	First law of thermodynamics and Second law of thermodynamics
3	Study of different types of boiler
4	Study of Boiler mounting and accessories
5	Study of various types of burners and fuels
6	Determination of calorific values of different fuels
7	Study of vapour compression refrigeration test rig
8	Study of heat pump
9	Properties of wet and dry steam
10	Properties of saturated and superheated steam
11	Use of Steam tables and Moiler charts
12	Dryness fraction of steam
13	Use 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

Suggested Readings [FE-124]:

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

Semester	**:**	**II**		
Course No.	**:**	**FE-125**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Unit Operations in Food Processing**		

SYLLABUS

Objectives: (i) To familiarize with commonly involved unit operations in food processing,

(ii) To differentiate between blanching, pasteurization and sterilization,

(iii) To apply these unit operations in food product development.

THEORY

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation.

Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices.

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

Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations.

Crystallization and Dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization.

Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation, distillation of wines and spirits.

Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment.

FE-125...

Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment.

Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger.

Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package.

Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification.

PRACTICAL

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

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TEACHING SCHEDULE

THEORY [FE-125]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1	Evaporation	Principles of Evaporation, Mass and Energy balance	5
2-3	Factors affecting on Evaporation	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.	5
4 - 5	Types of Evaporators	Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation.	5
6 - 7	Evaporation System	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.	5
8 - 9	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;	5
10 - 11	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.	5
12	Frozen Food Storage	Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, Equipment and Practice	5
13 - 14	Extraction	Liquid-liquid extraction processes, Types of equipment and Design for liquid-liquid extraction, Continuous multistage counter current extraction;	5
15	Expression	Leaching: process, Preparation of solids, Rate of leaching, Types of equipment, Equilibrium relations.	5

Continued….

16 - 17	Crystallization and Dissolution	Theory and Principles, Kinetics, Applications in food industry, Equipments for crystallization.	5
18 - 19	Distillation	Principles, Vapour-liquid equilibrium, Continuous flow distillation, Batch/ differential distillation, Fractional distillation, Steam distillation, Distillation of wines and spirits.	5
20 - 21	Baking	Principles, Baked foods, Baking equipment; Roasting: Principles of roasting, Roasting equipment.	5
22	Frying	Theory and Principles, Shallow or contact frying and deep fat frying,	5
23	Frying and Puffing Equipments	Heat and mass transfer in frying, Frying equipment; Puffing: Puffing methods, Puffing equipments	5
24	Blanching	Principles and Equipment	5
25 - 27	Pasteurization and Heat Exchanger	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	10
28 - 29	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, Equipments for sterilizing goods in the package	5
30 - 31	Aseptic Processing	Principles, Analysis of thermal resilience, Duration mathematics of conduction heating; Thermal processing and Microbial death curves	5
32	Homogenization and Emulsification	Principles and Methods	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-125]

Exercise No.	Exercise Title
1	Study of working principle of open pan evaporator and estimation of heat/mass balance during concentration of liquid foods
2	Study of working principle of vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods
3	Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods
4	Multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods
5	Effect of sample particle size and time on solvent extraction process
6	Effect of temperature on crystallization rate of sugar
7	Study of freezers/ Design problems on freezers
8	To study freezing of foods by different methods of IQF freezing
9	Determination of freezing time of a food material
10	To study simple distillation process and determine the rate of distillation
11	To study the process of roasting/ To study the effect of time-temperature combination on roasting
12	Determination of oil uptake by the food product during frying.
13	To determine the efficacy of a blanching process
14	Time-temperature combination for a blanching process
15	Efficacy of a sterilization process
16	Determination of F value for a product in can/retortable pouch
17	Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators

Suggested Readings [FE-125] :

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.

Continued….

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.

B.Tech. (Food Technology)

List/ Bouquet/ Basket of Skill Enhancement Courses (SECs)

Sr. No.	Course No.	Course Title	Credit Hrs.
Department of Food Technology			
1.	**SEC-xxx**	Introduction to Drying Technology and Dryers	2(0+2)
2.	**SEC-xxx**	Introduction to Processing of Extruded Foods	2(0+2)
3.	**SEC-xxx**	Introduction to Milling (Rice, Dal, Spices, etc.)	2(0+2)
Department of Food Quality Assurance			
4.	**SEC-xxx**	Introduction to Food Safety and Sanitation	2(0+2)
5.	**SEC-xxx**	Introduction to Good Laboratory Practices	2(0+2)
6.	**SEC-xxx**	Basic Food Analysis Laboratory Techniques	2(0+2)
Department of Food Engineering			
7.	**SEC-xxx**	Introduction to Electrical and Control Systems in Food Industry	2(0+2)
8.	**SEC-xxx**	Introduction to Mechanical Systems in Food Industry	2(0+2)
9.	**SEC-xxx**	Introduction to AutoCAD	2(0+2)
Department of Food Plant Operations			
10.	**SEC-xxx**	Maintenance of Food Processing Equipments	2(0+2)
11.	**SEC-xxx**	Introduction to Bottling and Canning Line	2(0+2)
12.	**SEC-xxx**	Introduction to Manufacturing of Bakery Products	2(0+2)

Note: (i) Skill Enhancement Courses can be added/offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject. *However, students have to select/ get offered the SECs as mentioned against the Nomenclature of UG-Certificate and such course(s) is/are to be selected from respective disciplines.

(ii) Above list/ bouquet of SEC courses is an indicative list and subject to modification as applicable therein.

(iii) In case of unavailability of the detailed course-wise syllabus/ teaching schedules of any of above SEC courses, the same can be primarily developed and followed at College/ University level in the academic year, 2024-25. However, the same can be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

Skill Enhancement Courses (SECs): Detailed Syllabi

[*in continuation of the SECs' Syllabi prescribed under I-Semester*]

Discipline: Food Technology : Department of Food Plant Operations

Semester	**:**	**II**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Maintenance of Food Processing Equipments**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Hands on identification of various types of food processing equipment
3-4	Creation of customized preventive maintenance checklists for different equipment
5-6	Simulated execution of a preventive maintenance routine
7	Understanding the types of lubricants used in food processing
8	Practicing proper lubrication techniques on machinery
9-10	Learning about different cleaning agents and their appropriate use
11-12	Conductingcleaningprotocolsonequipmentincompliancewithfoodsafety standards
13-14	Practical exercises in electrical trouble shooting, including circuit testing and voltage measurement
15-16	Dismantling and reassembling parts of common food processing equipment
17-18	Simulated trouble shooting of common equipment malfunctions
19-20	Simulating the documentation of maintenance activities and creating maintenance logs
21	Study of maintenance of cleaning equipment
22-23	Study of care and maintenance of Sorting/Grading equipment
24-25	Study of care and maintenance of Milling equipment
26-27	Study of and care and maintenance of Drying equipment
28-29	Study of care and maintenance of Material Handling equipment
30-31	Study of care and maintenance of Packaging equipment
32	Study of care and maintenance of Storage units

Semester	**:**	**II**			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Bottling and Canning Line**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	Introduction to bottling and canning process
3	Study of sorting and grading equipments
4	Study of washing equipments
5	Study of peeling methods and equipments
6	Study of cutting equipments
7	To perform the blanching of fruits and vegetables
8	To check the adequacy of blanching process
9-10	Study of different types of bottles and cans, including materials and sizes
11	Study of different filling techniques (gravity, pressure, vacuum)
12	Practical session on filling bottles/cans accurately
13	Cut out analysis of cans
14	Hands-on practice on in-bottle sterilization
15	Hands-on practice with various sea ling methods (screw caps, corks, can lids)
16	Testing seal integrity using various methods
17	Practical session on labeling machinery operation
18	Coding and printing best practices for product information
19	Conduct quality checks on filled and sealed products
20	Discuss common quality issues and troubleshooting techniques
21	Study of domestic carbonator and carbonation process
22	Learn proper cleaning and sanitation protocols for equipment
23-24	Hands-on cleaning sessions for different parts of the line
25	Basic maintenance tasks for key equipments
26	Troubleshooting common problems in bottling and canning lines
27	Workshop on regulations affecting bottling and canning
28	Product Handling and Storage
29	Practical session on proper storage techniques
30-31	Study of packaging, labelling and FSSAI Regulations of beverages and canned products
32	Visit to Beverage and Canning Industry

Semester	**:**	**II**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Manufacturing of Bakery Products**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Introduction and market survey of bakery products
3-4	Study of different methods of preparation of bakery products (Bread, Biscuit, Cake and Cookies etc.)
5-6	Determination of Gluten Content in wheat flour
7-8	Determination of Sedimentation value of wheat flour
9-10	Determination of Pelshenke value of wheat flour
11-12	Determination of water and oil absorption of flour
13-14	Determination of emulsion capacity and stability of flour
15-16	Determination of foaming capacity and stability of flour
17-18	Determination of alkaline water retention capacity of flour
19-20	Preparation and quality evaluation of composite formulation of wheat-based cookies
21-22	Preparation and quality evaluation of millet-based cookie formulations
23-24	Preparation and quality evaluation of crackers
25-26	Preparation and quality evaluation of unleavened flat breads
27-28	Preparation and quality evaluation of leavened breads (White bread, Brown bread)
29	Preparation and quality evaluation of cake/muffin
30	Preparation and quality evaluation of baked cereal bar
31	Study of packaging, labeling and FSSAI Regulations of bakery products
32	Visit to Commercial Bakery Unit.

Course Curriculum of Third Semester

as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in

FOOD TECHNOLOGY

- UG-Certificate in Food Technology
- UG-Diploma in Food Technology
- UG-Degree: B.Tech. (Food Technology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. R.B. Kshirsagar

Associate Dean & Principal, College of Food Technology, VNMKV, Parbhani.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Curriculum of Third Semester as per the
ICAR-Sixth Deans' Committee Report for Academic Programmes in
FOOD TECHNOLOGY

Course Layout

B.Tech. (Food Technology)

Semester: III (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr.No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**AEC-234**	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	--
2.	**MDC-232**	Agricultural Marketing and Trade	3(2+1)	--
3.	**FT-MATH-232**	Engineering Mathematics-I	2(2+0)	--
4.	**FQA-234**	Food Chemistry-II	3(2+1)	--
5.	**FQA-235**	Food Microbiology	3(2+1)	--
6.	**FE-236**	Fluid Mechanics	3(2+1)	--
7.	**FE-237**	Heat and Mass Transfer in Food Processing	3(2+1)	--
8.	**FE-238**	Basic Electronic Engineering	2(1+1)	--
9.	**SEC-235**	Skill Enhancement Course-V[#] *(To be offered from the bouquet of SECs)*	2(0+2)	--
10.	**OC-1/ OC-2/ ...**	Online Course (s) / MOOCs[†]	As opted by student	**NG**
		Total Credits Hrs.=	**23(13+10)**	**G**

AEC: Ability Enhancement Course, **MDC**: Multidisciplinary Course, **OC**: Online Course, **SEC**: Skill Enhancement Course, **G**: Gradial; **NG**: Non-gradial

[†]**Note:** It is mandatory for each Student to complete **total 6 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

For the students with exit option with of UG-Diploma in Food Technology

*Nomenclature of Diploma	SEC to be selected from the respective disciplines	
	Semester-III	**Semester-IV**
UG-Diploma in Food Technology (Food Plant Operations)	Food Engineering	Food Plant Operations
UG-Diploma in Food Technology (Food Manufacturing)	Food Technology	Food Plant Operations
UG-Diploma in Food Technology (Food Quality Testing)	Food Quality Assurance	Food Plant Operations

Semester	**:**	**III**		
Course No.	**:**	**AEC-234**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Physical Education, First Aid, Yoga Practices and Meditation**		
Gradial Common Course across all UG Degrees				

SYLLABUS

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

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

PRACTICAL

Physical Education; Training and Coaching- Meaning and concept; Aerobic and Aerobic exercises; Calisthenics, Weight Training, Circuit Training, Interval Training, Fartlek Training; Effect of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition- Effect of Diet on Performance; Physiological Changes due to ageing and Role of exercise on ageing process; Personality, its dimensions and types, Role of Sports in Personality Development; Motivation and Achievements in Sports; Learning and Theories of Learning; Adolescent Problems and its Management; Posture; Postural Deformities, Exercises for Good Posture.

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

- Asanas (Definitions and Importance)- Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimothasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left & right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan.
- Suryanamaskar, Pranayama (Definitions and Importance)- Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
- Meditation (Definitions and Importance)- Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definitions and Importance)- Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of Yoga in Sports.
- Teaching of Asanas- Demonstration, Practice, Correction and Practice.

History of Sports and Ancient games, Governance of Sports in India; Important Sporting events- Awards in sports, History, Latest rules, Measurement 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 techniques, 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 muscles related injuries; First Aid-related with Nervous system and Unconsciousness; First Aid-related with Gastrointestinal Tract, Skin Burns; First Aid-related with Bites and stings, poisoning; First Aid-related with Sense organs; Handling and transport of injured traumatized persons- Sports injuries and their Treatments.

TEACHING SCHEDULE

PRACTICAL [AEC-234]

Exercise No.	Topic	Exercise Title / Sub-topics
1	**Physical Education**	To study the training and coaching- Meaning and concept of Physical Education
2 - 7	**Methods of Training**	To study the method of training- Aerobic and Aerobic exercises
		To study the method of training- Calisthenics
		To study the method of training- Weight Training
		To study the method of training- Circuit Training
		To study the method of training- Interval Training
		To study the method of training- Fartlek Training
8	**Effect of Exercise**	To study the effect of exercise on Muscular, Respiratory, Circulatory and Digestive systems
9	**Balanced Diet and Nutrition**	To study the Balanced Diet and Nutrition- Effect of diet on performance
10	**Physiological Changes**	To study the physiological changes due to ageing and role of exercise on ageing process
11	**Personality Development**	To study the dimensions and types -Role of sports in personality development
12	**Motivation and Achievements in Sports**	To study the Motivation and Achievements in Sports

Continued…

13	**Learning and Theories of Learning**	To study the Learning and Theories of Learning
14	**Adolescent Problems and its Management**	To study the Adolescent Problems and its Management
15	**Posture**	To study the Postural Deformities, Exercises for Good Posture
16 - 22	**Yoga**	To study the Introduction, History and Types of Yoga
		To study the Asanas: Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left leg- right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan
		To study the Suryanamaskar, Pranayama, Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari
		To study the Meditation, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
		To study the Mudras: Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
		To study the Role of Yoga in Sports
		To study the Demonstration, Practice, Correction and Practice of Asanas
23 - 26	**Sports**	To study the History of Sports and Ancient games
		To study the Governance of Sports in India
		To study the Awards in Sports, History, Latest rules, Measurement of playfield, Specifications of equipment in important sporting events
		To study the Skill, Technique, Style and Coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics)

Continued…

27 - 32	**First Aid**	To study the Need and Requirement of First Aid- First Aid techniques, Equipment and Upkeep
		To study the First aid related with Respiratory system, Heart, Blood and Circulation
		To study the First aid related with Wounds and Injuries, Bones, Joints muscles related injuries
		To study the First aid related with Nervous system Unconsciousness, Sense organs.
		To study the First aid related with Gastrointestinal Tract, Skin Burns, Bites and Stings, Poisoning
		To study the Handling and Transport of Injured Traumatized Persons- Sports Injuries and their Treatments.

Semester	**:**	**III**		
Course No.	**:**	**MDC-232**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Agricultural Marketing and Trade**		
Gradial Common Course among 3 UG Degrees (with different Course Nos.) viz., **B.Sc. (Hons.) Horti. / B.Tech. (Food Tech.) / B.Sc. (Hons.) ABM**				

SYLLABUS

Objectives:

(i) To understand the fundamentals of Agricultural Marketing and Trade,

(ii) To analyse the factors influencing supply and demand in agricultural markets,

(iii) To explore different marketing channels and strategies in Agriculture,

(iv) To examine the role of Government Policies and Regulations in agricultural markets.

THEORY

Agricultural Marketing: Concepts and Definitions of Market, Marketing, Agricultural Marketing, Market structure, Marketing mix and Market segmentation, Classification and Characteristics of Agricultural markets; Demand, Supply and Producer's surplus of agri-commodities: Nature and Determinants of demand and supply of farm products, Producer's surplus – Meaning and its types, Marketable and Marketed surplus, Factors affecting marketable surplus of agri-commodities; Pricing and promotion strategies: Pricing considerations and approaches – Cost-based and Competition-based pricing; Market promotion – advertising, Personal selling, Sales promotion and Publicity– their meaning and merits and demerits; Marketing process and Functions: Marketing process concentration, dispersion and equalization; Exchange functions – buying and selling; physical functions – storage, transport and processing; Facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and Definition of Marketing Channel; Number of channel levels; Marketing channels for different farm products; Integration, Efficiency, Costs and Price spread: Meaning, Definitions and Types of market integration; Marketing efficiency; Marketing costs, margins and price spread; Factors affecting cost of marketing; Reasons for higher marketing costs of farm commodities; Ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- NAFED, TRIFED, NCDC, APEDA, CWC, SWC,FCI, CACP, DMI – their objectives and functions;

Cooperative marketing in India; Risk in marketing: Types of risk in marketing; Speculation and hedging; An overview of futures trading; Agricultural prices and policy: Meaning and functions of price; Administered prices; Need for agricultural price policy; Trade: Concept of International Trade and its need, Theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian Agriculture; IPR. Role of APMC and its relevance in the present-day context.

PRACTICAL [MDC-232]

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.

TEACHING SCHEDULE

THEORY [MDC-232]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Market and Marketing	Meaning – Definitions – Components of market – Market structure – Meaning – Components – Market conduct – Market performance	4
2	Agricultural Marketing	Meaning – Definition – Scope – Subject matter – Importance of Agricultural Marketing in economic development.	6
3		Market structure, Marketing mix and Market segmentation	
4	Classification and Characteristics of Agricultural Market	Classification of markets – On the basis of Location, Area of coverage, Time span, Volume of transaction, Nature of transaction, Number of commodities, Degree of competition, Nature of commodities, Stage of marketing, Extent of public intervention, Type of population served, Accrual of marketing margins.	4
5	Demand and Supply	Demand, Supply and Producer's surplus of agri-commodities: Nature and Determinants of demand and Supply of farm products,	4
6	Producer's Surplus	Meaning- Marketable surplus- Marketed surplus- Importance- Factors influencing marketable surplus of agri-commodities	4
7 - 8	Pricing and promotion strategies	Pricing and promotion strategies; Pricing Considerations and Approaches – Cost-based and Competition-based pricing	6
9	Market Promotion	Advertising, Personal selling, Sales promotion and Publicity – their Meaning and Merits & Demerits;	4
10	Marketing Process and Functions	Marketing Process Concentration, Dispersion and Equalization	12
11		Marketing functions – Meaning- Exchange functions – Buying and Selling	
12		Physical Functions – Storage, Transport and Processing	
13		Facilitating Functions – Packaging, Branding, Grading, Quality control and Labeling (AGMARK)	
14	Market Functionaries and Marketing Channels	Types and Importance of agencies involved in Agricultural Marketing;	8
15 - 16		Meaning and Definition of Marketing Channel; Number of channel levels; Marketing channels for different farm products;	

Continued…

17	Market Integration	Definition-Types of Market integration- Horizontal, Vertical and Conglomeration-	4
18	Marketing Efficiency	Meaning- Definitions- Technical or Physical or Operational efficiency- Pricing or Allocative efficiency-	4
19	Marketing Cost	Marketing Cost- Margins- Price spread- Factors affecting the costs of marketing- Reasons for higher marketing costs of agricultural commodities- Ways of reducing marketing costs for farm products-	4
20	Role of Govt. in Agricultural Marketing	Govt. in Agricultural Marketing- Remedial measures, Regulated markets- Definition- Important features of Regulated markets, Functions, Progress and Defects-	4
21 - 22	Public Sector Institutions	Objectives and Functions of: ~ National Agricultural Cooperative Marketing Federation (NAFED)- Tribal Cooperative Marketing Development Federation (TRIFED)- National Cooperative Development Corporation (NCDC)- Agricultural and Processed Food Products Export Development Authority (APEDA)- Central Warehousing Corporation (CWC)- State Warehousing Corporations (SWC)- Food Corporation of India (FCI)- Commission for Agricultural Cost and Prices (CACP)- Directorate of Marketing & Inspection (DMI)-	6
23	Cooperative Marketing	Meaning- Structure- Functions of Cooperative Marketing Societies-	2
24	Risk in Marketing	Types of Risk in Marketing-	6
25		Speculation & Hedging-; An overview of Futures trading-	
26	Agricultural Prices and Policy	Meaning and Functions of Price; Administered prices; Need for Agricultural Price Policy-	4
27 - 28	International Trade	Concept of International Trade and its Need, International trade- Definition- International vs. Interregional trade- Free trade vs. Protection-	10
29		Theories of Absolute and Comparative Advantage-	
30		Present status and Prospects of international trade in Agri-commodities-; GATT and WTO-	
31		Agreement on Agriculture (AoA) and its implications on Indian Agriculture-; Intellectual Property Rights (IPR)-	
32	APMC	Role of APMC and its relevance in the present-day context-	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-232]

Exercise No.	Exercise Title
1	Plotting and Study of demand and supply curves.
2	Calculation of price and income elasticity of demand.
3	Study of the relationship between market arrivals and prices of selected commodities.
4	Computation of marketable and marketed surplus of important commodities.
5	Study of price behaviour (seasonal indices) over time for selected commodities.
6	Construction of simple and weighted price index numbers.
7	Visit to the local market to study different marketing functions performed by different Agencies.
8	Study and Identification of marketing channels for selected commodities.
9	Collection of data and estimation of marketing cost, marketing margin and price spread of selected commodities.
10	Introduction to different Public Agricultural Marketing Web Portals- (AgMarkNet, MSAMB).
11	Visit to NAFED –Organisational and Functional Study.
12	Visit to SWC/CWC- Study of Warehousing Operations.
13	Visit to Co-operative Marketing Society –Functional analysis.
14	Visit to Local Processing Unit.
15	Application of Absolute Advantage Theory in International Trade.
16	Application of Comparative Advantage Theory in International Trade.

Suggested Readings [MDC-232]:

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

Semester	**:**	**III**	
Course No.	**:**	**FT-MATH-232**	**Credit Hrs. : 2(2+0)**
Course Title	**:**	**Engineering Mathematics-I**	

SYLLABUS

Objectives :

(i) To gain knowledge about curves and their expression in mathematical form,

(ii) To develop equations for a process and its integration.

THEORY

Differential Calculus: Taylor's and Maclaurin's expansions, Indeterminate form.

Partial Differentiation: 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.

Integral Calculus: Gamma and Beta functions, Double and Triple integrals, Change of order of integration, Application of double and Triple integrals to find area and volume.

Differential Equations: 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.

Vector Calculus: 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.

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TEACHING SCHEDULE

THEORY [FT-MATH-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 8	**Differential Calculus**	Taylor's and Maclaurin's expansions (Statement), Indeterminate Forms	25
		Partial Differentiation: Function of two or more independent variables, Partial differentiation	
		Homogeneous functions and Euler's theorem (Without proof)	
		Composite functions (Chain Rule without proof), Total Derivatives	
		Derivative of an implicit function	
		Change of variables	
9 - 16	**Integral Calculus**	Gamma and Beta functions	25
		Double and Triple integrals	
		Change of Order of Integration	
		Application of double and triple integrals to find area and volume	
17 - 26	**Differential Equations**	Bernoulli's differential equations	30
		Exact differential equations	
		Equations reducible to exact form by integrating factors (I.F. for homogenous equation, I.F. of the equation of the type $f_1(xy)ydx + f_2(xy)xdy = 0$)	
		Equations of first order and higher degree, Clairaut's equation (Definition, General solution)	
		Differential equations of higher orders, Methods of finding complementary functions	
		Particular Integrals (for the function of Type e^{ax}, $\sin(ax+b)/\cos(ax+b)$, x^m)	
27 - 32	**Vector Calculus**	Differentiation of vectors, Scalar and Vector point functions	20
		Vector differential operator Del, Gradient of a scalar point function	
		Divergence and Curl of a vector point function,	
		Identities involving Del, Second order differential operator (Without proof)	
		Total =	**100**

Suggested Readings [FT-MATH-232]:

1. **Grewal B. S. 2015**. Higher Engineering Mathematics. Khanna Publishers, N. Delhi. (43rd Edn)
2. **Narayan, S. 2016**. *A Text Book of Vector*. S. Chand and Co. Ltd., New Delhi.
3. **Narayan, S. 2016.** *Differential Calculus*. S. Chand and Co. Ltd., New Delhi.
4. **Narayan, S. 2016**. *Integral Calculus*. S. Chand and Co. Ltd., New Delhi.

Semester : III		
Course No. : FQA-234	**Credit Hrs. : 3(2+1)**	
Course Title : Food Chemistry-II		

SYLLABUS

Objectives :

(i) To study chemical aspects of food and bio-materials and their importance in food processing,
(ii) To gain an understanding of chemicals responsible for flavour, pigments and colorants,
(iii) To understand the effects of processing on these biomolecules,
(iv) To gain the knowledge about role of enzymes in food processing.

THEORY

Vitamins: Definition, Classification, Vitamin functions in body and deficiency conditions, Requirements, Allowances, Enrichment, Restorations, Fortifications, Losses of vitamins, Optimization and Retention of vitamins.

Minerals: Definition, Classification, Minerals function in body and deficiency conditions, Requirements, Allowances, Enrichment, Restorations, Fortifications, Losses of minerals, Optimization and Retention of minerals.

Food Colours: Definition, Sources, Classifications, Characteristics, Use of colours in food and their functional properties, Regulatory use of food dyes, Impact of thermal processing on food colour and dye.

Pigments in Animal and Plant Kingdoms: Heme pigments, Chlorophyll, Carotenoids, Phenolic and Flavonoids, Betalins, Effect of processing on pigment behavior.

Philosophy and Definitions of Flavour: Chemistry of Food Flavour; Flavourmatics/ Flavouring compounds, Sensory assessment of flavour, Technology for flavour retention.

Various Anti-nutritional Factors: Sources, Mode of action, Methods for reduction/inactivation; **Enzymes in Food Processing:** Introduction, Carbohydrases, Proteases, Lipases, Sources, classification. Role of endogenous enzymes in food quality, Enzymes use as processing aid, Enzyme specificity, Regulation mechanism.

PRACTICAL

Determination of Water-soluble Vitamins (Thiamine, Riboflavin, Vitamin C, Vit.); Determination of ascorbic acid by dye method; Determination of Fat-soluble Vitamin (Vit A-Total Carotenoids); Determination of Vitamin E; Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium and phosphorus; Estimation of iron and magnesium; Qualitative tests for flavour compounds; Estimation of tannins from food; Estimation of phytic acid from food; Determination of artificial colours; Determination of natural colours; Assessment of hydrocolloids as food additives; Determination of enzymatic action on fruit vegetables like potato, brinjal etc.; Assessment of various pectinases from fruits; Assessment of various pectinases from vegetables.

TEACHING SCHEDULE

THEORY [FQA-234]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Vitamins	Definition, Classification, Vitamin functions in body and Deficiency conditions	5
3 - 5		Requirements, Allowances, Enrichment, restorations, Fortifications, Losses of vitamins, Optimization and Retention of vitamins.	10
6 - 7	Minerals	Definition, Classification, Minerals function in body and Deficiency conditions	5
8 - 10		Requirements, Allowances, Enrichment, Restorations, Fortifications, Losses of minerals, Optimization and Retention of minerals	10
11 - 13	Natural Colours, Dyes	Definition, Sources, Classifications, Characteristics, Use of colours in food and their functional properties. Regulatory use of food dyes, Impact of thermal processing on food colour and dye	15
14 - 16	Pigments in Animal and Plant Kingdoms	Heme pigments, Chlorophyll, Carotenoids, Phenolic and Flavonoids, Betalins, Effect of processing on pigment behavior.	15
17 - 18	Food Flavours	Philosophy and Definitions of flavour, Chemistry of food flavour	5
19 - 21		Flavourmatics/ Flavouring compounds, Sensory assessment of flavour, Technology for flavour retention	5

Continued…

22 - 23	Anti-nutritional Factors	Various anti-nutritional factors and their sources	5
24 - 25		Mode of action, Methods for reduction/ inactivation.	5
26 - 27	Enzymes Use in Food Processing	Introduction of Enzymes: Carbohydrases, Proteases, Lipases.	5
28 - 29		Sources, Classification, Role of endogenous enzymes in food quality.	5
30 - 32		Enzymes use as processing aid, Enzyme specificity, Regulation mechanism.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FQA-234]

Exercise No.	Exercise Title
1	Determination of water-soluble vitamins (Thiamine, Riboflavin, Vitamin C)
2	Determination of Ascorbic acid by dye method
3	Determination of fat-soluble vitamin (Vitamin A- Total carotenoid)
4	Determination of Vitamin E
5	Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations)
6	Estimation of calcium and phosphorus
7	Estimation of iron and magnesium
8	Qualitative tests for flavour compounds
9	Estimation of tannins from food
10	Estimation of phytic acid from food
11	Determination of artificial colours
12	Determination of natural colours
13	Assessment of hydrocolloids as food additives
14	Determination of enzymatic action on fruit vegetables like potato, brinjal etc.
15	Assessment of various pectinases from fruits
16	Assessment of various pectinases from vegetables

Suggested Readings (FQA-234):

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.
3. **Meyer, L.H. 2004.** Food Chemistry, CBS Publishers & Distributors, New Delhi (India).
4. **Robert, J. Whitehurst and Barry A. Law. 2002.** Enzymes in Food Technology, Sheffield Academic Press, CRC Press, UK.
5. **DeMan, J.M. 1999.** Principles of Food Chemistry, 3rd Edition, An Aspen Publication, Gaithersburg, Maryland.
6. **Benjamin K. Simpson 2012.** Food Biochemistry and Food Processing, 2nd Edition, Wiley-Blackwell, A John Wiley & Sons Ltd., Publication.
7. **Manay, N. Shakuntala and M. Shadaksharaswamy 2008.** Foods Facts and Principles (Third Revised Edition), New Age International (P) Limited, Publishers.
8. **Srinivasan Damodaran and Kirk L. Parkin 2017.** Fennema's Food Chemistry 5th Edition, CRC Press, Taylor & Francis Group.
9. FSSAI Manual of Methods of Analysis of Foods, Food Additives, Lab Manual 8. 2015. Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, New Delhi.
10. **AOAC. 2003.** Official Methods of Analysis of AOAC International. 17th Edn. Gaithersburg, MD, USA, Association of Analytical Communities.
11. Online course on Swayam Portal - Food Chemistry, by Dr. Chandra Nayaka S., University of Mysore.

Semester	**:**	**III**			
Course No.	**:**	**FQA-235**	**Credits Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Food Microbiology**			

SYLLABUS

Objectives :
(i) To study Microbiology of different foods,
(ii) To be skillful in detecting various food borne toxins,
(iii) To be able to understand spoilage of food, increasing awareness and desire to help sections of society.

THEORY

Importance and Significance of microbes in Food Science; Sources of microorganisms in foods and their effective control; Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, Water activity, Nutrients, Redox potential, Oxygen etc., Extrinsic factors: Relative humidity, Temperature, Gaseous atmosphere etc. Normal Microbiological quality of Foods and its significance: Milk and milk products, Fruits and vegetables, Cereals and cereal products, Meat and meat products, Fish and other sea foods, Poultry and Eggs; Sugar and Sugar products, Slats and Spices and Canned foods; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, Non-nitrogenous organic compounds, Organic acids, Other compounds, Lipids, Pectic substances; Shelf life: Calculation of shelf life, Shelf-life requirements, Deteriorative reactions, Accelerated testing; Simulations of product: Package environment interaction, Shelf-life simulation for moisture, Oxygen and Light sensitive products; Microbial toxins; Bacterial toxins, Fungal toxins, Algal toxins and Mushroom toxins; Food borne intoxications and infections: Types of food involved, Toxicity and Symptoms, Chemical properties, Environmental conditions; Food borne viruses: Types of food involved, Noroviruses, Rota viruses, Prion diseases, Toxicity and Symptoms.

PRACTICAL

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation;
Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation;
Microbial examination of milk and milk products: Identification, isolation and confirmation;
Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation; Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

TEACHING SCHEDULE

THEORY [FQA-235]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Importance and Significance	Importance and Significance of microbes in Food Science	5
3 - 4	Sources	Sources of microorganisms in foods and their effective control	5
5 - 7	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.	10
8 - 10	Normal Microbiological Quality of Foods and its Significance	Milk and Milk products, Fruits and Vegetables, Cereals and Cereal products	10
11 - 13		Meat and Meat products, Fish and other sea foods, Poultry and eggs; Sugar and sugar products, Salts and spices and Canned foods	10
14 - 16	Chemical Changes caused by Microorganisms	Changes in Nitrogenous organic compounds, Non-nitrogenous organic compounds, Organic acids, Other compounds, Lipids, Pectic substances	10
17 - 19	Shelf Life	Calculation of shelf life, Shelf-life requirements. Deteriorative reactions, Accelerated testing	10
20 - 22	Simulations of Product	Package environment interaction, Shelf-life simulation for moisture, Oxygen and Light sensitive products	10
23 - 26	Microbial Toxins	Bacterial toxins, Fungal toxins, Algal toxins and Mushroom toxins	10
27 - 29	Food borne Intoxications and Infections:	Types of food involved, Toxicity and Symptoms, Chemical properties, Environmental conditions	10
30 - 32	Food borne Viruses:	Types of food involved, Noroviruses, Rota viruses, Prion diseases, Toxicity and Symptoms	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FQA-235]

Exercise No.	Exercise Title
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 and salts: Identification, isolation and confirmation
9	Microbial examination of spices: Identification, isolation and confirmation
10	Microbial examination of canned products: Identification, isolation and confirmation
11	Determination and enumeration of coliform organisms in foods.
12	Thermal death time determination
13	Detection of Salmonella from food sample
14	Detection of coliforms from water by MPN method
15	Detection of *Staphylococcus aureus* from food sample
16	Determination and enumeration of Enterococcus organisms in foods

Suggested Readings [FQA-235]:

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.

Semester	**:**	**III**		
Course No.	**:**	**FE-236**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Fluid Mechanics**		

SYLLABUS

Objectives :

(i) To get idea about types of fluids and their properties,

(ii) To gain knowledge about the flow behaviour of the fluids,

(iii) To differentiate about various types of pumps and their use in food processing.

THEORY

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, Absolute and gauge pressure, Pressure head of a liquid; Pressure on vertical rectangular surfaces, Flow behavior of viscous fluids; Compressible and non-compressible fluids; Surface tension, capillarity, Pressure measuring devices: Simple, Differential, Micro-, Inclined manometer, Mechanical gauges, Piezometer; Floating bodies: Archimedes principle, Stability of floating bodies; Equilibrium of floating bodies, Metacentric height; Fluid flow: Classification, Steady, Uniform and Non-uniform, Laminar and Turbulent, Continuity equation; Bernoulli's theorem and its applications; 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's Number, Reynold's number, Weber's number and Hydraulic similitude; Pumps: Classification, Centrifugal pumps, Submersible pumps, Reciprocating pumps, Positive displacement pump; Centrifugal pumps: Pumpsin 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's 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 plant.

TEACHING SCHEDULE

THEORY [FE-236]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Units and Dimensions	Definition, Importance, Laws, Equations, Types of units, SI System of Units and Dimensions.	5
2	Properties of Fluids	Definitions and Properties of fluids	5
3	Fluid Pressure	Types of fluids pressures, Static pressure of liquids: Hydraulic pressure, Absolute and Gauge pressure	5
4	Pressure Head	Pressure head of a liquid; Pressure on vertical rectangular surfaces	5
5 - 6	Types of Fluids	Viscous fluids; Compressible and Non-compressible fluids; Surface tension, Capillarity	5
7 - 9	Pressure Measuring Devices	Types, Working principles, Advantages and Disadvantages: Simple, Differential, Micro-, Inclined manometer, Mechanical gauges, Piezometer	10
10 - 11	Floating Bodies	Archimedes principle, Stability of floating bodies; Equilibrium of floating bodies, Metacentric height	5
12 - 14	Fluid Flow	Classification, Steady, Uniform and Non-uniform, Laminar and Turbulent, Continuity equation; Bernoulli's theorem and its applications	5

Continued…

15 - 17	Flow through Pipes	Loss of head, Determination of pipe diameter; Determination of discharge, Friction factor, Critical velocity	5
18 - 20		Flow through orifices, Mouthpieces, Notches and Weirs; Vena contracta, Hydraulic coefficients, Discharge losses	5
21 - 22		Time for emptying a tank; Loss of head due to contraction, Enlargement at entrance and Exit of pipe	5
23 - 24		External and Internal mouthpieces, Types of notches, Rectangular and Triangular notches, Rectangular weirs; Venturimeters, pitot tube, Rotameter; Water level point gauge, Hook gauge	5
25 - 26	Dimensional Analysis	Buckingham's theorem application to fluid flow phenomena, Froude's Number, Reynold's number, Weber's number and Hydraulic similitude	5
27	Pumps	Classification, Centrifugal pumps, Submersible pumps, Reciprocating pumps, Positive displacement pump	5
28 - 30		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:	15
31 - 32	Working of 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.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-236]

Exercise No.	Exercise Title
1	Study of different tools and fittings
2	Study on flow rate versus pressure drop with U-tube manometer
3	Study of mechanical gauges
4	Studies on verification of Bernoulli's theorem
5	Determination of discharge co-efficient for venturi
6	Determination of discharge co-efficient for orifice, V-notch
7	Verification of emptying time formula for a tank
8	Determination of critical Reynold's number by Reynold apparatus
9	Study of reciprocating, centrifugal and gear pump
10	Study on Calibration process of rotameter
11	Study of different types of valves
12	Study of pumps for viscous fluid, floating bodies, liquid flow
13	Study of venturimeter and orificemeter
14	Study of weir and flow through pipes
15	Study and operation of centrifugal pump
16	Study and operation of other pumps used in dairy and food processing plants

Suggested Readings [FE-236]:

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

Semester	**:**	**III**	
Course No.	**:**	**FE-237**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Heat and Mass Transfer in Food Processing**	

SYLLABUS

Objectives :
(i) To understand the mechanism of heat and mass transfer,
(ii) To get knowledge of dimensionless numbers involved in heat and mass transfer,
(iii) To identify and distinguish between different types of heat exchangers.

THEORY

Basic heat transfer processes, Heat transfer coefficients, Properties related to heat transfer, Food properties, Measurements and errors; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, Hollow sphere and Cylinder with linear heat transfer, Uniform/Non-uniform heat generation, Development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries; Convection: Forced and free convection, Use of dimensional analysis for correlating variables affecting convection heat transfer; Dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, Some important empirical relations used for determination of heat transfer coefficient; Heat transfer to flowing fluids; Radiation: Heat radiation, Emissivity, Absorptivity, Transmissivity, Radiation through black and Grey surfaces, Determination of shape factors; Heat Exchangers: General discussion, Fouling factors, Jacketed kettles, LMTD, Parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design; Efficiency and NTU analysis; Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, Steady state diffusion of gases and liquids through solids, Equimolal diffusion, Isothermal evaporation of water into air, Mass transfer coefficient, Application in dairy and food industry.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FE-237]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Basic Heat Transfer process	Basic heat transfer processes, Heat transfer coefficients, Properties related to heat transfer, Food properties measurements and errors	5
3 - 4	One dimensional steady state heat conduction	One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Heat transfer through composite walls and insulated pipelines	10
5 - 8	One-dimensional steady state heat conduction with heat generation	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	15
9 - 12	Extended surface heat exchange	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;	10

Continued…

13 - 14	Unsteady State heat conduction	Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries	5
15 - 18	Convection Heat Transfer	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; Heat transfer to flowing fluids	10
19 - 22	Radiation Heat Transfer	Radiation: Heat radiation, Emissivity, Absorptivity, Transmissivity, Radiation through black and Grey surfaces, Determination of shape factors	10
23 - 28	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	20
29 - 32	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.	15
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-237]

Exercise No.	Exercise Title
1	Study the Heat transfer analysis during conduction process- (Numericals: Heat conduction)
2	Study the Heat transfer analysis during convection process- (Numericals: Heat convection)
3	Study of working principle and constructional details of plate heat exchanger
4	Study of working principle and constructional details of shell and tube heat exchanger
5	Study of working principle and constructional details of extended surface and double pipe heat exchanger
6	Determination of overall heat transfer coefficient of shell and tube heat exchanger
7	Determination of overall heat transfer coefficient of plate heat exchangers, jacketed kettle used in food industry
8	Study the preparation and calibration of thermocouples
9	Determination of thermal conductivity of different food products
10 - 11	Studies on heat transfer through extended surfaces
12	Studies on temperature distribution and heat transfer in HTST pasteurizer;
13 - 14	Studies on determination of mass transfer coefficient in foods
15	Studies on glass transition temperature of food sample
16	Determination of mass transfer during leaching process.

Suggested Readings [FE-237]:

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

Semester	**:**	**III**			
Course No.	**:**	**FE-238**	**Credit Hrs.**	**:**	**2(1+1)**
Course Title	**:**	**Basic Electronics Engineering**			

SYLLABUS

Objectives :
(i) To study basic concepts of electronics and their relevance in food industry,
(ii) Get idea about various electronic components,
(iii) Knowledge about electronic device and their concept in measurement.

THEORY

Semiconductors, P-n junction, V-I characteristics of P-n junction, Diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); Voltage multiplier, Filter circuits; Bipolar junction transistor: Operating point, Classification (A, B and C) of amplifier, Various biasing methods (fixed, self, potential divider); Ideal OP-AMP characteristics, Linear and 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; 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.

TEACHING SCHEDULE

THEORY [FE-238]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1 - 2	Introduction to Basic Electronics Engineering	Introduction to Semiconductors, P-n junction, V-I characteristics of P-n junction, Diode as a circuit element, Rectifier	10
3 - 4	Diodes	Diode circuits for OR and AND (both positive and negative logic); Voltage multiplier, Filter circuits	10
5 - 7	Transistors	Bipolar junction transistor: Operating point, Classification (A, B and C) of amplifier, Various biasing methods (fixed, self, potential divider)	10
8 - 9	OP-AMP	Ideal OP-AMP characteristics, Linear and Nonlinear applications of OP-AMP integrator, Active rectifier, Comparator, Differentiator, Differential, Instrumentation amplifier and oscillator	15
10 - 11	Regulators	Zener diode voltage regulator, Transistor series regulator, Current limiters, OP-AMP voltage regulators	10
12 - 13	Boolean Algebra and Gates	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
14	Transducers	Transducers: Classification, Selection criteria, Characteristics, Sensors and Actuators construction, Working principles, Applications of following transducers	10
15	Potentiometers	Potentiometers RTD, Thermocouples, Thermistors, LVDT, Strain gauges, Capacitive and Inductive transducers	10
16	Piezoelectric transducers	Piezoelectric transducers, Photoelectric transducers, Self-generating transducers, Variable parameter type, Digital, Actuating and controlling devices.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-238]

Exercise No.	Exercise Title
1	Study of diode characteristics
2	Study of triode characteristics
3	Study of Zener diode
4	Study of V-I characteristics of P-n junction diode
5	Study of RC coupled amplifier
6	Study of RC phase shift oscillator
7	Study of full wave rectifier
8	Verification of logic gates
9	Determination of energy gap in a junction diode
10	Study of transistor characteristics in CE configuration
11	Study of OP-Amp IC 741 as differential amplifier
12	Study of half wave rectifier
13	Study of OP-AMP IC 741 as an active rectifier
14	Study of transistor characteristics
15	Study of temperature characteristics of resistor
16	Study of diode as clipper and clamper

Suggested Readings [FE-238]:

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.

B.Tech. (Food Technology)

#List/ Bouquet of Skill Enhancement Courses (SECs)

[in continuation of the SECs' Syllabi prescribed under I and II semesters]

Sr. No.	Course No.	Course Title	Credit Hrs.
Department of Food Technology			
1.	**SEC-xxx**	Introduction to Drying Technology and Dryers	2(0+2)
2.	**SEC-xxx**	Introduction to Processing of Extruded Foods	2(0+2)
3.	**SEC-xxx**	Introduction to Milling (Rice, Dal, Spices, etc.)	2(0+2)
Department of Food Quality Assurance			
4.	**SEC-xxx**	Introduction to Food Safety and Sanitation	2(0+2)
5.	**SEC-xxx**	Introduction to Good Laboratory Practices	2(0+2)
6.	**SEC-xxx**	Basic Food Analysis Laboratory Techniques	2(0+2)
Department of Food Engineering			
7.	**SEC-xxx**	Introduction to Electrical and Control Systems in Food Industry	2(0+2)
8.	**SEC-xxx**	Introduction to Mechanical Systems in Food Industry	2(0+2)
9.	**SEC-xxx**	Introduction to AutoCAD	2(0+2)
Department of Food Plant Operations			
10.	**SEC-xxx**	Maintenance of Food Processing Equipments	2(0+2)
11.	**SEC-xxx**	Introduction to Bottling and Canning Line	2(0+2)
12.	**SEC-xxx**	Introduction to Manufacturing of Bakery Products	2(0+2)

Note: (i) Skill Enhancement Courses can be added/ offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject. ***However, students with exit option have to select/ get offered the SECs as mentioned against the Nomenclature of UG-Diploma and such course(s) is/are to be selected from respective dept./disciplines.**

(ii) Above list/ bouquet of SEC courses is an indicative list and subject to modification as applicable therein.

(iii) In case of unavailability of the detailed course-wise syllabus/ teaching schedules of any of above SEC courses, the same can be primarily developed and followed at College/ University level in the current academic year. However, the same can be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

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Discipline: Food Technology - Department of Food Technology

Semester	**:**	*As being offered/ opted*			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Drying Technology and Dryers**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction to drying process and its mechanism
2	Understanding of different methods for moisture estimation
3	Determination of moisture content with oven method
4	Determination of drying characteristics and study of kinetics
5	Prediction of moisture sorption isotherms
6	Determination of equilibrium moisture content of grain
7	Introduction to different dryings theories and its importance
8	Introduction to different methods of drying (contact, convective and radiation).
9	Principle and operational mechanism involved in cabinet and tunnel drying
10	Principle and operational mechanism involved in spray drying
11	Principle and operational mechanism involved in roller/ drum drying
12	Principle and operational mechanism involved in fluidized bed drying
13	Principle and operational mechanism involved in foam-mat drying
14	Principle and operational mechanism involved in microwave drying
15	Principle and operational mechanism involved in vacuum oven drying
16	Principle and operational mechanism involved in solar drying
17	Principle and operational mechanism involved in refractance window drying of foods
18	Study of pretreatment methods for drying and dehydration
19	Study of operational principle and working of freeze dryer
20	Study of Rehydration/ Reconstitution properties of dehydrated foods
21	Drying of fruit slices in cabinet drier
22	Drying of green leafy vegetables

Continued...

23	Drying of mango/ other pulp by foam-mat drying
24	Drying of foods using roller dryer and spray dryer
25	Drying of foods using freeze drying process
26	Preparation of mango leather
27	Preparation of Osmo-dehydrated food products (candied fruits, glazed fruits)
28	Preparation of dehydrated raisins
29	Study of packaging, labeling and FSSAI Regulations of Dehydrated products
30 - 31	Industrial Visit to different dehydration Units.
32	Case study on fruits and vegetable drying

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Processing of Extruded Foods**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction and market survey of extruded products
2	Introduction of food extruders components and their functions
3 - 4	Principle and operational mechanism involved in cold and hot extruder (Single and Twin-Screw Extruder)
5	Preparation of spaghetti pasta
6	Preparation of penne pasta
7	Preparation of noodles
8	Preparation of vermicelli
9	Preparation of instant noodles
10	Quality evaluation of pasta products
11 - 12	Demonstration of extrusion products (extruded snacks/ breakfast cereal/ texturized vegetable protein)
13	Preparation of traditional extruded products (sev/ chakli)
14	Evaluation of physical properties of expanded snacks
15	Evaluation of water and milk hydration properties of breakfast cereal
16	Evaluation of functional properties of expanded snacks
17	Evaluation of functional properties of texturized vegetable protein.
18	Preparation of plant-based meat analogue by using extruder
19	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking
20	Preparation of extruded confectionary product
21	Effect of feed moisture content on extrudate food product characteristic
22	Studies on development of weaning food by Extrusion technology
23	Texture profile analysis of extruded product
24	Preparation of dietary fiber rich extruded product
25	Quality evaluation of commercially available extruded food products
26	Packaging of extruded products
27	Quality evaluation of different extruded products
28	Determination of techno-economic feasibility of prepared extruded product
29	Sensory evaluation of prepared extruded products
30	Labeling and FSSAI Regulations of different extruded products.
31 - 32	Visit to Commercial Extrusion Unit.

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Milling (Rice, Dal, Spices etc.)**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction and market survey of milled rice, dal and spices.
2	Determination of physical properties of rice grain, dal and spices.
3	To study the defects in grains and milled rice, dal and spices by physical observation
4	Determination of moisture content in different milled product.
5	Studies on traditional methods of milling of dal and rice grains.
6	Cleaning of rice, dal and spices for milling
7	Studies on different dehusking and deshelling equipment's involved in the milling of paddy grains.
8	Principles and operational mechanism of rice mills
9	Determination of Head Rice Yield (HRY), Milled Rice Yield (MRY) and % brokens.
10	Determination of polishing quality of paddy
11	Studies on different byproducts of paddy milling
12	Studies on different methods and pretreatments involved in pulse milling
13	Studies on dry milling and wet milling of pulses for production of dal
14	Principles and operational mechanism of dal mills
15	Cleaning and inspection for effective grading and sieving of grains based on size and grade.
16	Demonstration of the procedure of cleaning of unprocessed whole spices.
17	Principles and operational mechanism spice mills
18	Manufacture of dalia from cereal and legumes
19	Production process of rice from paddy
20	Study on mini dal mill
21	Studies on utilization of byproduct from dal milling industry.
22	Preparation of turmeric powder

Continued...

Introduction to Milling (Rice, Dal, Spices etc.)…

23	Preparation of curry powder
24	Recipe formulation and preparation of different spice mix powders - (Turmeric, Chilli, Onion, Ginger etc.).
25	Sieve analysis of milled products for particle size distribution
26	Milling yield calculation for different grains
27	Packaging and storage techniques for milled products.
28	Techno-economic feasibility of prepared spice powder and milled dal
29	Case study on spice powder processing industries
30	To study milling quality of rice, dal and spices
31	Study of packaging, labelling and FSSAI regulations of dehydrated products
32	Visit to commercial rice mill, dal mill and spice industry

Discipline: Food Technology - Department of Food Quality Assurance

Semester	**:**	*As being offered/ opted*			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Food Safety and Sanitation**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Understanding food safety and sanitation: concept, terms and importance
3-4	Developing the process flow for the food establishment including all the inputs, outputs and interim loops
5-6	Data collection for identification of biological, chemical and physical hazards
7	Hazard Analysis using FMEA technique for risk assessment
8	Demonstration of correct method of washing hands
9-10	Assessment of personal hygiene
11-12	Identifying the key focus areas for GHP and GMP
13-14	Identifying gaps in its implementation; closure plans for identified gaps
15-16	Importance of temperature control and demonstrating proper cooking, cooling and reheating temperatures using thermometers
17	Introduction to HACCP
18-19	Development of OPRP (Operational Pre-requisite Programme) and Development of HACCP Plan (Critical Limits including Rationale for Limits)
20-21	Monitoring procedure, correction and corrective measures
22-23	Introduction to cleaning agents and techniques for sanitizing surfaces
24-25	Hands-on Demonstration of using chemical sanitizers correctly
26-27	To recognize signs of pest infestations and methods of control
28-29	Demonstration of segregation of waste
30-31	To study proper disposal methods for different types of waste
32	Practice identifying common food allergens and labeling

Semester	**:**	*As being offered/ opted*			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Good Laboratory Practices**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Introduction and importance of Good Laboratory Practices (GLPs)
3-4	Practical session on identifying hazards and using appropriate personal protective equipment
5-6	Hands-on practice with common lab equipment (e.g. microscopes, pipettes, balances, centrifuges etc.)
7-8	Equipment calibration techniques and how to properly maintain instruments
9-10	Techniques for cleaning, drying and sterilizing lab glassware to prevent contamination
11-12	Autoclave operation for sterilization, calibration of balances, pH meters and spectrophotometers
13-14	Sample collection techniques for biological, chemical or environmental samples
15-16	Correct labeling and storage procedures to maintain integrity
17-18	Proper segregation and disposal of hazardous and non-hazardous lab waste
19-20	Understanding chemical compatibility and safe disposal practices
21-23	Performing basic quality control tests like titration, pH measurement and UV-Vis Spectrophotometry to assess the purity and quality of samples
24-26	Aseptic techniques for handling microbial cultures, preparing agar plates and transferring cultures
27-29	Detecting, recording and reporting errors or deviations in experimental work
30-32	Writing and following SOPs for basic lab techniques like, solution preparation or instrument usage

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Basic Food Analysis Laboratory Techniques**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Sampling plan; Sample collection and preparation for analysis
3-4	Sensory evaluation techniques of food products
5-6	Quality evaluation of food products for color and taste of marketed products
7-8	Determination of moisture content in food samples
9-10	Water analysis
11-12	Determination of ash content in food samples
13	Determination of crude fat in food samples
14-15	Determination of crude protein in food samples by Kjeldahl method
16	Determination of crude fibre in food samples
17	Qualitative tests for sugars
18-19	Qualitative tests for proteins, Colorimetric estimation of protein concentration
20-21	Estimation of total and reducing sugars
22-23	Measuring the pH of various food samples, like fruits, dairy, and beverages
24-25	Determining the acidity in food samples by titrating with a base
26-27	Determination of Total Soluble Solids and Vitamin C in food samples
28	Determination of Salt Content in food samples
29-30	Estimation of chlorophyll and carotenoids in food samples
31	Estimation of Macro and Micro minerals
32	Visit to NABL-Accredited Food Laboratory

Discipline: Food Technology - Department of Food Engineering

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs. :**	**2(0+2)**
Course Title	**:**	**Introduction to Electrical and Control Systems in Food Industry**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Build simple electrical circuits using resistors, capacitors and inductors
3	Measurement of voltage, current and resistance using a multimeter
4-5	Explore different types of sensors used in food processing
6-7	Performing calibration exercises with EC/pH meter- Study of different types of motors (AC, DC, Stepper) and their applications
8-9	Developing a motor control circuit for a conveyor system
10-11	Programming simple control sequences using PLC software
12	Creating a basic ladder logic diagram for a conveyor belt system
13	Simulating PID control for a temperature control system
14-15	Designing a simple HMI using software tools (like, Factory Talk or WinCC)
16-17	Integrating the HMI with PLC for monitoring and control
18-19	Setting-up a small SCADA system for monitoring a food processing operation
20-21	Understanding data logging and visualization techniques
22	Learning about industrial communication protocols (Modbus, Ethernet/IP)
23	Creating a simple network setup to connect PLCs and HMIs
24-25	Building and analyze a control loop for a food processing scenario (e.g. Pasteurization)
26	Understanding feedback mechanisms and their importance in control systems
27	To diagnose and troubleshoot faulty electrical circuits
28	To develop systematic approaches to identify common issues
29	To measure and analyze energy consumption in a small-scale food processing set-up
30	To explore energy-saving practices and technologies in the industry
31	Safety protocols in electrical systems
32	Visit of food industry for practical exposure of electrical and control system

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Mechanical Systems in Food Industry**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Introduction to mechanical system and its application in food industry
3-4	To identify and understand the function of basic mechanical components (Gears, Belts, Pulleys, Bearings) used in food machinery
5-6	To study different materials used in food machinery and their properties
7-8	To practice the assembly and disassembly of simple food processing machines (e.g., Mixers, Blenders)
9-10	To measure and analyze vibration in food processing equipment
11-12	To learn how to identify issues such as misalignment or imbalance
13-14	To perform routine maintenance tasks on mechanical systems - (Lubrication, Belt tensioning)
15-16	To conduct troubleshooting exercises to identify and fix common mechanical failures
17	Study of principles, construction and working of cleaning equipments
18	Study of principles, construction and working of sorting/grading equipments
19	Study of principles, construction and working of washing equipments
20	Study of principles, construction and working of handling equipments
21	Study of principles, construction and working of food packaging machines
22-23	To conduct tests to evaluate corrosion resistance and suitability for food contact
24-25	To explore the use of robotic systems for tasks such as packing or palletizing
26-27	To implement quality control measures in a mechanical process (e.g. Measuring dimensions of food products)
28-29	To create basic mechanical drawings using CAD software
30-31	Project work to enlist various mechanical parts and its functionality in different food processing industries
32	Visit of Food Industry to identify mechanical systems in food processing

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to AutoCAD**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Introduction to AutoCAD and its application in the food processing industry
3-4	Familiarization with the AutoCAD interface: toolbars, menus and command line
5	Practice using drawing tools to create geometric shapes
6-7	Experiment with drawing precision using grid and snap features
8	Learning to modify objects using commands such as move, copy, rotate, scale and mirror
9	To perform exercises on editing shapes and lines in an existing drawing
10	To create and manage layers in a drawing
11	To assign different colours and line types to layers for better organization
12	To add linear, radial and angular dimensions to drawings
13-14	To practice dimensioning techniques and understand best practices for clarity
15	To insert text and annotations into a drawing
16	To explores tyles and formatting options for clarity and presentation
17-18	To draw a complete 2D engineering drawing of an equipment
19	Introduction to 3D modeling: create basic 3D shapes (cubes, cylinders)
20-21	To practice using 3D viewing tools and rendering techniques
22-23	Setting-up a layout for printing: scaling, title blocks and viewports
24-25	Understanding the file types and compatibility issues (DWG, DXF) to save the AutoCAD files
26	To attach and manage external references in a drawing
27-28	To develop a detailed plan (floor plan, mechanical part) incorporating multiple elements
29-30	To create isometric drawings to represent three-dimensional objects in two dimensions
31-32	To practice isometric dimensioning and labeling

Discipline: Food Technology - Department of Food Plant Operations

Semester	**:**	*As being offered/ opted*			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Maintenance of Food Processing Equipments**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Hands on identification of various types of food processing equipment.
3-4	Creation of customized preventive maintenance check lists for different equipments.
5-6	Simulated execution of a preventive maintenance routine
7	Understanding the types of lubricants used in food processing
8	Practicing proper lubrication techniques on machinery
9-10	Learning about different cleaning agents and their appropriate use
11-12	Conducting cleaning protocols on equipment incompliance with food safety standards
13-14	Practical exercises in electrical trouble shooting, including circuit testing and voltage measurement
15-16	Dismantling and reassembling parts of common food processing equipment
17-18	Simulated troubleshooting of common equip mental functions
19-20	Simulating the documentation of maintenance activities and creating maintenance logs
21	Study of maintenance of cleaning equipment
22-23	Study of care and maintenance of sorting/ grading equipment
24-25	Study of care and maintenance of milling equipment
26-27	Study of care and maintenance of drying equipment
28-29	Study of care and maintenance of material handling equipment
30-31	Study of care and maintenance of packaging equipment
32	Study of care and maintenance of storage units.

Semester	**:**	*As being offered/ opted*			
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Bottling and Canning Line**			

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	Introduction to bottling and canning process
3	Study of sorting and grading equipments
4	Study of washing equipments
5	Study of peeling methods and equipments
6	Study of cutting equipments
7	To perform the blanching of fruits and vegetables
8	To check the adequacy of blanching process
9-10	Study of different types of bottles and cans, including materials and sizes
11	Study of different filling techniques (gravity, pressure, vacuum)
12	Practical session on filling bottles/cans accurately
13	Cut-out analysis of cans
14	Hands-on practice on in-bottle sterilization
15	Hands-on practice with various sea ling methods (screw caps, corks, can lids)
16	Testing seal integrity using various methods
17	Practical session on labeling machinery operation
18	Coding and printing best practices for product information
19	Conduct quality checks on filled and sealed products
20	Discuss common quality issues and troubleshooting techniques
21	Study of domestic carbonator and carbonation process
22	Learn proper cleaning and sanitation protocols for equipment
23-24	Hands-on cleaning sessions for different parts of the line
25	Basic maintenance tasks for key equipments
26	Troubleshooting common problems in bottling and canning lines
27	Workshop on regulations affecting bottling and canning
28	Product handling and storage
29	Practical session on proper storage techniques
30-31	Study of packaging, labeling and FSSAI regulations of beverages and canned products
32	Visit to beverage and canning industry

Semester	**:**	*As being offered/ opted*		
Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Introduction to Manufacturing of Bakery Products**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1-2	Introduction and market survey of bakery products
3-4	Study of different methods of preparation of bakery products (bread, biscuit, cake and cookies etc.)
5-6	Determination of gluten content in wheat flour
7-8	Determination of sedimentation value of wheat flour
9-10	Determination of Pelshenke value of wheat flour
11-12	Determination of water and oil absorption of flour
13-14	Determination of emulsion capacity and stability of flour
15-16	Determination of foaming capacity and stability of flour
17-18	Determination of alkaline water retention capacity of flour
19-20	Preparation and quality evaluation of composite formulation of wheat-based cookies
21-22	Preparation and quality evaluation of millet-based cookie formulations
23-24	Preparation and quality evaluation of crackers
25-26	Preparation and quality evaluation of unleavened flat breads
27-28	Preparation and quality evaluation of leavened breads (White bread, Brown bread)
29	Preparation and quality evaluation of cake/muffin
30	Preparation and quality evaluation of baked cereal bar
31	Study of packaging, labeling and FSSAI regulations of bakery products
32	Visit to Commercial Bakery Unit

Course Curriculum of Fourth Semester

as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in

FOOD TECHNOLOGY

- UG-Certificate in Food Technology
- UG-Diploma in Food Technology
- UG-Degree: B.Tech. (Food Technology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. R.B. Kshirsagar

Associate Dean & Principal, College of Food Technology, VNMKV, Parbhani.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26

Course Layout

B.Tech. (Food Technology)

Semester: IV (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**MDC-242**	Entrepreneurship Development and Business Management	3(2+1)	--
2.	**VAC-242**	Agricultural Informatics and Artificial Intelligence	3(2+1)	--
3.	**FT-MATH-243**	Engineering Mathematics-II	2(2+0)	--
4.	**FE-249**	Fundamentals of Food Engineering	3(2+1)	--
5.	**FQA-246**	Food Plant Sanitation	3(2+1)	--
6.	**FQA-247**	Food Quality, Safety Standards and Certification	2(2+0)	--
7.	**FPO-241**	Food Plant Utilities and Services	3(2+1)	--
8.	**SEC-246**	Skill Enhancement Course-VI[#] *(To be offered from the bouquet of SECs)*	2(0+2)	--
9.	**OC-1 / OC-2/ ...**	Online Course(s) / MOOCs[†]	As opted by student	NG
		Total Credits Hrs. =	**21(14+7)**	**G**
MDC: Multidisciplinary Course, **VAC**: Value Added Course; **SEC**: Skill Enhancement Course; **OC**: Online Course; **G**: Gradial; **NG**: Non-gradial				
Post-IV Semester (Only for Exit option for award of UG-Diploma*)				
10.	**INT-242**	Internship (10-week)	10(0+10)	NG

[†]**Note:** It is mandatory for each Student to complete **total 6 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

Note: Students taking various SKILL ENHANCEMENT COURSES will be eligible to get a UG-Diploma with Nomenclature as follows, provided the student has to select courses as mentioned against the nomenclature of the UG-Diploma.

*Nomenclature of Diploma	SEC to be selected from the respective disciplines	
	Semester-III	Semester-IV
UG-Diploma in Food Technology (Food Plant Operations)	Food Engineering	Food Plant Operations
UG-Diploma in Food Technology (Food Manufacturing)	Food Technology	Food Plant Operations
UG-Diploma in Food Technology (Food Quality Testing)	Food Quality Assurance	Food Plant Operations

Semester	**:**	**IV**	
Course No.	**:**	**MDC-242**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Entrepreneurship Development and Business Management**	
Gradial Common Course among 4 UG degrees viz., B.Sc. (Hons.) Agriculture, B.Tech. (Agricultural Engineering), B.Tech. (Food Technology), B.Sc. (Hons.) Agri-Business Management (~with Course No. **MDC-243**)			

SYLLABUS

Objectives:

(i) To provide an insight into the concept and scope of entrepreneurship,
(ii) To expose the student to various aspects of establishment and management of a small business unit,
(iii) To enable the student to develop financially viable agribusiness proposal.

THEORY

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

PRACTICAL

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

TEACHING SCHEDULE

THEORY [MDC-242]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction to Entrepreneurship	Meaning and Definitions of an Entrepreneur, Entrepreneurship; Concept & Scope of Entrepreneurship	6
2	Importance of Entrepreneurship	Importance of Entrepreneurship in Agribusiness	
3	Entrepreneurship Development	Need for and objectives of Entrepreneurial development	4
4	Motivational Factors	Types of motivational factors, Role of social and environmental factors in entrepreneurship	4
5	Characteristics of Entrepreneurs	Characteristics, Entrepreneurial attributes and Competencies	4
6	Types of Entrepreneurs	Various types and their significance	4
7	Functions of Entrepreneurs	Key roles and Responsibilities	2
8	Evolution of Entrepreneurship	Historical perspective and Growth	3
9	Process of Entrepreneurship Development	Stages and Approaches in developing entrepreneurship	4
10	Environmental Scanning	Need for scanning, Techniques	2
11	Opportunity Identification	Spotting and Analysing opportunities	2
12	Infrastructure and Support Systems	Policies, Schemes and Role of financial and other agencies in entrepreneurship development	4
13	Enterprise Functioning Steps	Steps to establish an enterprise	4
14	Selection of Products/Services	Choosing products, Services and Business forms	3
15	Enterprise Location and Capital Sources	Registration, Site selection, Capital sources/Acquisition	3
16	Manufacturing and Distribution	Acquiring manufacturing know-how, Packaging and Distribution essentials	3
17	Planning of an Enterprise	Short term and Long-term planning of an enterprise	3
18 - 19	Project Formulation	Project identification, Selection, Steps in project formulation and Report preparation, etc.	8
20	Enterprise Management	Basics and Importance of managing an enterprise	3

Continued….

21	Production Management	Product types, Levels of products, Product mix, Quality control, Cost of production, Production control	4
22	Material Management	Raw material costing and Inventory control strategies	4
23	Personnel Management/Human Resource Management	Manpower planning, Labour turnover, Wages/Salaries	4
24	Financial Management	Funds, Fixed and Working capital, Costing, Pricing, Book-keeping basics	4
25 - 26	Accounting and Taxation	Journals, Ledgers, Subsidiary books, Annual financial statements, Taxation basics	4
27	Marketing Management	Market, Types of markets, Marketing assistance	4
28 - 29	Market Strategies and Pricing	Marketing strategies, Pricing strategies and Market penetration	4
30	Crisis Management	Crisis types, Strategies for managing raw material, etc.	2
31	Leadership in Crisis Situations	Role of leadership in handling crises	2
32	Financial Crises and Solutions	Strategies for financial crisis management	2
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-242]

Exercise No.	Exercise Topic/Title
1	Visit to Small-Scale Industries/Agro-Industries. (Objective: To understand setup and operations of small-scale units)
2	Interaction with Successful Entrepreneurs. (Objective: To gain insights from real-life entrepreneurial experiences)
3	Case Study on Agro-Entrepreneurs. (Objective: To analyse successful agribusiness ventures)
4	Visit to Financial Institutions. (Objective: To learn about funding options and financial support)
5	Identification of Agribusiness Ideas. (Objective: To identify viable agribusiness ideas based on demand)
6	Analysing Project Proposals. (Objective: To study structure and elements of project proposals)

Continued…

7	Preparing a Project Proposal. (Objective: To develop a basic proposal for an agribusiness venture)
8	Project Report Writing Techniques. (Objective: To practice format and structure for project reports)
9	Marketing Strategies Case Study. (Objective: To analyse effective marketing strategies in agribusiness)
10	Production and Cost Control Analysis (Objective: To study basic cost control measures in production)
11	Inventory Control Simulation (Objective: To apply inventory management methods in a hypothetical setup)
12	Basic Bookkeeping (Objective: To practice fundamental bookkeeping for small businesses)
13	Market Research Techniques (Objective: To use surveys and questionnaires for market insights)
14	Project Proposal Presentation (Objective: To present project ideas for feedback)
15	Review of Project Proposal (Objective: To refine project proposals based on feedback)
16	Final Evaluation of Proposals (Objective: To assess and finalize projects)

Suggested Readings [MDC-242]:

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

Semester	**:**	**IV**
Course No.	**:**	**VAC-242**
Credit Hrs.	**:**	**3(2+1)**
Course Title	**:**	**Agricultural Informatics and Artificial Intelligence**
Gradial Common Course across 8 UG degrees viz., B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Horticulture, B.Tech. (Biotechnology), B.Tech. (Food Technology), B.Sc. (Hons.) Agri-Business Management, B.Sc. (Hons.) Forestry, B.F.Sc. (Hons.), B.Sc. (Hons.) Community Science		

SYLLABUS

Objectives :

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

(ii) To provide basic knowledge of computer with applications in Agriculture.

(iii) To make the students familiar with Agricultural-Informatics, its components and applications in Agriculture and Artificial Intelligence.

THEORY

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office® for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database- concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to general programming concepts and standard input/output operations. e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, input-output files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System: Soil Information Systems etc. for supporting farm decisions.

Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India. Introduction to Artificial Intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in Agriculture for autonomous crop management and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce and other food processing applications; Concepts of Smart Agriculture, Use of AI in Food and Nutrition Science etc.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [VAC-242]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	**Introduction to Computers, Anatomy of Computers** **Memory Concepts:** **Operating System:**	Definitions; Characteristics of Computer; Components of Computer; CPU: CU, ALU, MU; Input Devices; Output Devices; Units of Memory: bit to TB, Types: Primary, Secondary; Definitions and Types: Single user, Multi-user and features. OS Special Types (Brief Overview): Batch, Real-Time, Time Sharing, Distributed, Network OS. Functions of operating system	7
4 - 6	**Applications of MS Office®**	MS Word: Creating a New Document, Formatting option features; Insertion of Table; MS Excel: Creating worksheet and graph, Functions for Data Analysis: AVERAGE, COUNT, SUM, MIN, MAX, MEDIAN, MODE, STDEV, STDEVP, VAR, VARP, CORREL, PERCENTILE; Mathematical functions in MS-Excel: SUM, AVERAGE, AVERAGEIF, COUNT, COUNTIF, MOD, ROUND	7
7 - 9	**Database and DBMS**	Database: Definitions, Concepts and Types; Uses of DBMS in Agriculture; Characteristics of Database; Structure of Database Management System, Tables: Concept of view, Primary key, Foreign key; Creating Database: SQL query: Create, Insert, Select, Delete, Update. Form: Steps for Creating Forms, Entering Data in forms, Report using MS-ACCESS: Steps for Creating Reports, Printing reports.	7

Continued…

10	**Internet and World Wide Web (www)**	Concepts and components; Internet: Introduction; Definition of LAN, WAN, MAN and Internet Internet Service Provider (ISP); World Wide Web; Hypertext; Web Browser; Web Page and Websites; E-Mail: Creating Email, Email Addresses, Using Email, Sending the message, CC and BCC; Search Engine	7
11 - 12	**Introduction to Computer Programming**	Computer Programming: Introduction, General concepts, Standard input/output operations.	7
13 - 14	**e-Agriculture**	Concepts, Application & Importance of IT in e-Agriculture; AGRINET: Introduction, Objectives; Advantages and Challenges in Agriculture.	7
15 - 16	**Computer Models in Agriculture**	Statistical, Weather Analysis and Crop Simulation Models; Concepts, Input-output files, Limitation, Advantages and Application of models for understanding plant processes, Sensitivity, Verification, Calibration and Validation	7
17 - 19	**IT and IOT Applications in Agriculture**	IT Applications & their role in Agriculture with emphasis on Computation of Water and Nutrient Requirement of Crop; IOT - Definition, Benefits/ Applications/ Uses in Agriculture: Precision Farming, Agricultural Drones, Smart Greenhouses, Drones; Challenges.	7

Continued…

20 - 21	**Computer-controlled Devices; Smartphone Apps and Geospatial Technology**	Computer-controlled Devices (Automated systems) for Agri-input management- Examples of Automation Devices: Robotics Application in Planting, Drones for Irrigation, Harvest Automation Tools, Automated Tractors etc., AWS - Automatic Weather Station, AIS - Automatic Irrigation System. Smartphone Mobile Apps in Agriculture- Introduction- Irrigation Systems, Fertilizer Application, Pest and Disease Management; Seeding and Planting, Harvesting Systems; Weather Forecasting, Soil Testing and Analysis, Crop Management, Market Prices; Farm Management, Financial & Insurance Services. Geospatial Technology (*in brief*) – Introduction, Techniques, Components and Uses for generating valuable agri-information.	7
22 - 23	**Decision Support System (DSS)**	DSS: Introduction, Concepts, Components, Types and Applications in Agriculture.	7
24 - 25	**Agriculture Expert System (AES)**	AES: Introduction, Concepts, Components and Applications in Agriculture- Soil Information Systems for supporting farm decisions.	7
26 - 27	**Contingent Crop Planning using IT Tools**	Preparation of Contingent Crop Planning and Crop Calendars: Introduction, Definition, Benefits, Steps to prepare Contingent Crop Planning & Calendars using IT Tools.	7
28 - 30	**Digital India and Schemes to promote Digitalization of Agriculture in India**	Digital India and Schemes to promote Digitalization of Agriculture in India; Digital Agriculture in India: Status, Challenge, Digital India and Initiatives in Agriculture Sector. Digital Agriculture or NeGP-A 2.0	8
31 - 32	**Introduction to and Uses of Artificial Intelligence (Overview)**	Introduction to Artificial Intelligence, Background and Applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in Agriculture for autonomous crop management and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce and other food processing applications; Concepts of Smart Agriculture, Use of AI in Food and Nutrition Science etc.	8
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [VAC-242]

Exercise No.	Exercise Title
1 - 2	Study of computer components, accessories, practice of important DOS command Introduction to different Operating systems- such as Windows, Unix/ Linux; Creating files and folders, Files Management.
3 - 4	Use of ~ MS-WORD: Creating files and folders; Files management and MS-POWERPOINT: Presentation for creating, editing and presenting scientific documents. MS-EXCEL: Mathematical calculations; Preparation of Spread sheets; Use of statistical tools; Writing expressions; Creating graphs; Analysis of scientific data.
5	MS-ACCESS: Creating Database; Preparing queries and reports.
6	Demonstration of Agri-information system(s)
7 - 8	Introduction of Programming Languages & Program in C-Language: a) Program to enter name and print name b) Program to calculate sum and subtraction of numbers c) Program to calculate Area of Circle d) Program to calculate Area of Triangle e) Program to calculate Area of Rectangle
9	Introduction to Internet, World Wide Web (WWW) and its components.
10 - 11	Hands-on Practice on Crop Simulation Models (CSM): CROPWAT 8.0/ DSSAT/ Crop-Info/ CropSyst/ Wofost/ etc. Computation of water and nutrient requirements of crop using CSM and IT tools.
12	Use of Smartphone Apps (developed by SAUs) and other devices in agro-advisory and dissemination of market information
13	Introduction to Geospatial Technology (Use of Open-source GIS Tools)
14	Study/ Demonstration of general AR/VR tools (as available)
15	Hands-on Practice on Decision Support System (DSS)
16	Introduction to India Digital Ecosystem of Agriculture (IDEA)

Suggested Readings [VAC-242]:

1. Fundamentals of Computer by V. Rajaraman, PHI Learning.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C.J. Date, Pearson Education, N. Delhi.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K. *et al.*, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa Publ.
8. Agricultural Informatics and Artificial Intelligence for B.Tech.(Agril Technology) by Prashant Publ.

- ***Online Resources: (VAC-242)***

  - https://en.wikipedia.org/wiki/Computer
  - https://www.javatpoint.com/computer
  - https://iasri.icar.gov.in/
  - https://www.nrsc.gov.in/EO_Agr_Objective?language_content_entity=en
  - https://www.agrimoon.com
  - https://www.agriinfo.in
  - https://eagri.org
  - https://www.agriglance.com
  - https://agritech.tnau.ac.in
  - https://loksabhadocs.nic.in/Refinput/New_Reference_Notes/English/Agriculture_and_Digital_India.pdf
  - https://www.investindia.gov.in/team-india-blogs/digitalisation-agriculture-india
  - http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
  - https://optimizeias.com/indias-digital-ecosystem-for-agriculture/
  - https://www.igi-global.com/chapter/introduction-to-agricultural-information-systems/266572#:~:text=Agricultural%20Information%20Systems%3A%20Information%20system,knowledge%20utilization%20by%20agricultural%20producers.
  - https://cropcalendar.apps.fao.org/#/home
  - http://www.irdindia.in/journal_ijrdmr/pdf/vol4_iss1/7.pdf
  - https://learn.microsoft.com/en-us/office365/servicedescriptions/office-applications-service-description/office-applications
  - https://ebooks.inflibnet.ac.in/hsp16/chapter/application-of-software-in-statisticalanalysis-i-microsoft-excel/
  - http://eagri.org/eagri50/STAM102/index.html
  - https://edu.gcfglobal.org/en/internetbasics/using-a-web-browser/1/
  - https://www.javatpoint.com/what-is-world-wide-web
  - https://www.mdpi.com/journal/agriculture/special_issues/Decision_Support_Systems_Application
  - https://apps.gov.in/ministry/ministry-agriculture
  - http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
  - https://apps.mgov.gov.in/apps_by_category;jsessionid=8206D0DAE69F48FB50962462A8922C23?name=Agriculture

➢ ***Tools available for Student for Academic Purpose only: (VAC-242)***

1. DSSAT (Decision Support System for Agrotechnology Transfer)
   - Purpose: A comprehensive crop modeling tool.
   - Use: Simulates plant growth, development, and yield for various crops under different management and environmental conditions.
   - Download:https://dssat.net/
2. APSIM (Agricultural Production Systems Simulator)
   - Purpose: A powerful plant simulation tool.
   - Use: Models the effects of environmental variables like soil, climate, and management strategies on plant growth and crop yield.
   - Download:https://www.apsim.info/
3. Open Sim Root
   - Purpose: A root growth modeling software.
   - Use: Helps understand plant root growth processes, interactions with soil, and how they respond to environmental conditions.
   - Download: Available as open-source software via research platforms like Git Hub.

   https://gitlab.com/rootmodels/OpenSimRoot
4. Virtual Plant
   - Purpose: A tool for visualizing and modeling plant metabolic and regulatory networks.
   - Use: Helps in understanding complex plant processes such as gene regulation, metabolic pathways, and how they respond to environmental conditions.

   Download: https://sourceforge.net/projects/virtualplant/
5. R Studio (with Bioconductor and Plant Modeling Libraries)
   - Purpose: A programming environment for statistical computing.
   - Use: Using plant modeling libraries like plant and photosynthesis, researchers can model plant growth, carbon assimilation, and nutrient cycling.
   - Download: https://posit.co/downloads/
6. WOFOST (World Food Studies)
   - Purpose: A plant process and crop growth simulation model developed by the FAO.
   - Use: Helps in understanding crop development, photosynthesis, and biomass accumulation under different environmental and management conditions.
   - Download:https://www.wur.nl/en/research-results/research-institutes/environmental-research/facilities-tools/software-models-and-databases/wofost/downloads-wofost.htm
7. Green Lab
   - Purpose: A plant growth model focused on plant architecture and functional growth processes.
   - Use: Simulates plant organ development and growth processes, integrating functional and structural aspects of plant behavior.
   - Download: https://greenlab.cirad.fr/GLUVED/html/P3_Tools/Tool_simul_003.html

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Semester	**:**	**IV**			
Course No.	**:**	**FT-MATH-243**	**Credit Hrs.**	**:**	**2(2+0)**
Course Title	**:**	**Engineering Mathematics-II**			

SYLLABUS

Objectives :

(i) To familiarize the students with basic concept of Mathematics.

(ii) To gain knowledge about matrix and their transformation.

(iii) To develop partial differential equations and their applications.

THEORY

Matrix:

Elementary transformation and rank of a matrix, Reduction to normal form, Gauss-Jordan method to find inverse of a matrix; Consistency and solution of linear equations; Eigen value and vectors, Cayley-Hamilton theorem; Linear and Orthogonal transformations

Derivative of function of complex variable:

Limit, Continuity, Derivative of function of complex variable; Analytical function, C-R equations, Conjugate function, Harmonic functions

Infinite series: Infinite series and its convergence,

Fourier series: 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

Partial Differential Equations:

Formation of partial differential equations; Lagrange's linear equation; Solution of non-linear partial differential equation

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TEACHING SCHEDULE

THEORY [FT-MATH-243]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 11	**Matrix**	Elementary transformation and Rank of a matrix	35
		Gauss-Jordan method to find inverse of a matrix	
		Reduction to normal form	
		Consistency and Solution of linear equations by Rouche's Theorem	
		Eigen value and Vectors (For non-repeated Eigen values)	
		Introduction to Linear and Orthogonal transformations	
		Cayley-Hamilton theorem (without proof and to find inverse of Matrix)	
12 - 16	**Derivative of Function of Complex Variable**	Limit, Continuity, Derivative of function of complex variable	15
		Analytical function, C-R equations (Cartesian Form)	
		Conjugate function, Harmonic functions	
17 - 19	**Infinite Series**	Definition of Infinite series and its convergence, Divergence and Oscillation.	10
		Geometric Series,	
		Tests of convergence: D'Alembert's Ratio Test	
20 - 27	**Fourier Series**	Periodic function (Definition)	25
		Euler's formulae for calculating Fourier coefficients	
		Dirichlet's conditions (Statement)	
		Fourier series of functions with arbitrary period $(-c, c), (0, 2c)$	
		Fourier series of odd and even functions	
		Half range sine and cosine series	
28 - 32	**Partial Differential Equations**	Formation of partial differential equations	15
		Lagrange's linear equation	
		Solution of non-linear partial differential equation of the First Order	
		Total=	**100**

Suggested Readings [FT-MATH-243]:

1. **Grewal B. S., 2015;** Higher Engineering Mathematics. Khanna Publishers Delhi. (43rd Edition)
2. **Narayan, S. 2016**. A Text Book of Vector. S. Chand and Co. Ltd., New Delhi.
3. **Narayan, S. 2016.** Differential Calculus. S. Chand and Co. Ltd., New Delhi.
4. **Narayan, S. 2016.** Integral Calculus. S. Chand and Co. Ltd., New Delhi.

Semester	**:**	**IV**		
Course No.	**:**	**FE-249**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Fundamentals of Food Engineering**		

SYLLABUS

Objectives :

(i) To understand basic concepts of Engineering principles applied to food.
(ii) To differentiate between drying and dehydration and different types of dryers.
(iii) To gain knowledge about basic operations like size reduction, mixing, separation etc.

THEORY

Drying and dehydration: Basic drying theory, Heat and Mass transfer in drying, Drying rate curves, Calculation of drying times, Dryer efficiencies; Classification and Selection of dryers; Tray, Vacuum, Osmotic, Fluidized bed, Pneumatic, Rotary, Tunnel, Trough, Bin, Belt, Microwave, IR, Heat pump and Freeze dryers; Dryers for liquid: Drum or roller dryer, Spray dryer and Foam-mat dryers. Size reduction: Benefits, Classification, Determination and Designation of the fineness of ground material, Sieve/screen analysis, Principle and Mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, Work index, Energy utilization; Size reduction equipment: Principal types, Crushers (Jaw crushers, Gyratory, Smooth roll), Hammer mills and Impactors, Attrition mills, Buhr mill, Tumbling mills, Ultra fine grinders, Fluid jet pulverizer, Colloid mill, Cutting machines (Slicing, Dicing, Shredding, Pulping). Mixing: Theory of solids mixing, Criteria of mixer effectiveness and Mixing indices, Rate of mixing, Theory of liquid mixing, Power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (Paddle agitators, Impeller agitators, Powder-liquid contacting devices, other mixers), Mixers for high viscosity liquids and pastes, Mixers for dry powders and particulate solids. Mechanical Separations: Theory, Centrifugation, Liquid-liquid centrifugation, Liquid-solid centrifugation, Clarifiers, Desludging and Decanting machine. Filtration: Theory of filtration, Rate of filtration, Pressure drop during filtration, Applications, Constant-rate filtration and Constant-pressure filtration, Derivation of equation; Filtration equipment; Plate and frame filter press, Rotary filters, Centrifugal filters and Air filters, Filter aids. Membrane separation: General considerations, Materials for membrane construction, Ultra-filtration, Microfiltration, Concentration, Polarization, Processing variables, Membrane fouling, Applications of ultra-filtration in food processing, Reverse osmosis, Mode of operation and Applications; Membrane separation methods, Demineralization by electro-dialysis, Gel filtration, Ion exchange, Per-evaporation and Osmotic dehydration.

PRACTICAL

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

TEACHING SCHEDULE

THEORY [FE-249]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	**Drying and Dehydration**	Basic drying theory, Heat and Mass transfer in drying, Drying rate curves, Calculation of drying times, Dryer efficiencies.	5
3 - 6	**Classification and Selection of Dryers**	Tray, Vacuum, Osmotic, Fluidized bed, Pneumatic, Rotary, Tunnel, Trough, Bin, Belt, Microwave, IR, Heat pump and Freeze dryers and Osmotic dehydration.	5
7 - 10	**Dryers for liquid**	Drum or roller dryer, Spray dryer and Foam-mat dryers.	5
11 - 12	**Size reduction**	Benefits, Classification, Determination and Designation of the fineness of ground material, Sieve/screen analysis, Principle and Mechanisms of Comminution of food, Rittinger's, Kick's and Bond's equations, Work index, Energy utilization.	5
13 - 14	**Size reduction equipment**	Principal types, Crushers (jaw crushers, Gyratory, smooth roll), Hammer mills and impactors, Attrition mills, Buhrmill, Tumbling mills, Tumbling mills, Ultra fine grinders, Fluid jet pulverizer, Colloid mill, Cutting machines (Slicing, Dicing, Shredding, Pulping).	10
15 - 18	**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.	15
19 - 22	**Mechanical Separations**	Theory, Centrifugation, Liquid-liquid centrifugation, Liquid-solid centrifugation, clarifiers, Desludging and decanting machine.	15

Continued...

23 - 26	**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.	15
27 - 30	**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	15
31 - 32	**Membrane Separation Methods**	Membrane separation methods, Demineralization by electro-dialysis, Gel filtration, Ion exchange, Per-evaporation	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FE-249]

Exercise No.	Exercise Title
1	Determination of fineness modulus and uniformity index
2	Determination of mixing index of a feed mixer (Numerical)
3	Determination of power requirement in size reduction of grain using Rittinger's law (Numerical)
4	Determination of power requirement in size reduction of grain using Kick's law and Bond's law (Numerical)
5	Study the performance evaluation of hammer mill
6	Study the performance evaluation of attrition mill
7	Study of centrifugal separator
8	Study of freeze dryer and freeze-drying process
9	Study on osmosis in fruits (Aonla)
10	Study on osmosis in fruits (Papaya)
11	Determination of solid gain and moisture loss during osmosis
12	Study of reverse osmosis process
13	Study of micro-filtration/membrane separation process
14	Study of ultra-filtration/membrane separation process
15	Study the drying characteristics for fruit drying
16	Determination of separation efficiency of the centrifugal separator (Numerical)

Suggested Readings [FE-249]:

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 infood 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.

Semester	**:**	**IV**			
Course No.	**:**	**FQA-246**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Food Plant Sanitation**			

SYLLABUS

Objectives : (i) To gain importance of sanitation and hygiene and its application to food.
(ii) To gain knowledge of Hazard Analysis and Critical Control Point
(iii) To learn good manufacturing practices.

THEORY

Sanitation and food industry: Sanitation, Sanitation laws, Regulations, and Guidelines, Establishment of sanitary Practices. Food borne bioterrorism: Potential risks and protection measures for bioterrorism. The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures. The Relationship of allergens to sanitation: Food allergens and its control measures. Food contamination sources: Sources of contamination, Contamination of foods, Protection against contamination. Personal hygiene and sanitary food handling: Personal hygiene, Employee hygiene, Sanitary food handling, Role of employee supervision, Employee responsibility. Cleaning compounds and sanitizers: Classification, Selection of cleaning compounds and sanitizers, CIP and COP, Handling and Storage, Precautions. Pest and Rodent Control: Insect infestation, Cockroaches, Insect destruction, Rodents, birds, Use of pesticides, Integrated Pest Management. Sanitary design and Construction for food processing: Site selection, site preparation, Building construction considerations, Processing and Design considerations, Pest control design. Waste product handling: Solid waste and Liquid waste management. Role of HACCP in sanitation: Good manufacturing practices, Current good manufacturing practices; Standard operating procedures, Good laboratory practices.

PRACTICAL

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices (GMPs) and Personal hygiene; Sewage treatment: Primary, Secondary, Tertiary and Quaternary; Aerobic and Anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and Identification of Actinomycetes; Enrichment and Isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coli form MPN test; Sampling of airborne microorganisms; Sampling of surfaces-equipment and physical plant; Aerosol sampling and Measurement guidelines

TEACHING SCHEDULE

THEORY [FQA-246]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	**Sanitation and Food Industry**	Sanitation, Sanitation laws, Regulations and Guidelines, Establishment of Sanitary Practices.	10
4 - 6	**Food-borne Bioterrorism**	Potential risks and Protection measures for Bioterrorism.	5
7 - 9	**Relationship of Microorganisms to Sanitation**	Microbial growth in relation to spoilage and food borne out breaks and its control measures.	10
10 -11	**Relationship of Allergens to Sanitation**	Food allergens and its control measures	5
12 - 14	**Food Contamination Sources**	Sources of contamination, Contamination of foods, Protection against contamination.	10
15 - 17	**Personal Hygiene and Sanitary Food Handling**	Personal hygiene, Employee hygiene, Sanitary food handling, Role of employee supervision, Employee responsibility.	10
18 - 20	**Cleaning Compounds and Sanitizers**	Classification, Selection of cleaning compounds and sanitizers, CIP and COP, Handling and storage, Precautions.	10
21 - 23	**Pest and Rodent Control**	Insect infestation, Cockroaches, Insect destruction, Rodents, Birds, Use of pesticides, Integrated Pest Management.	10
24 - 26	**Sanitary Design and Construction for Food Processing**	Site selection, Site preparation, Building construction considerations, Processing and Design considerations, Pest control design.	10
27 - 29	**Waste Product Handling**	Solid waste and Liquid waste management.	10
30 - 32	**Role of HACCP in Sanitation**	Good manufacturing practices, Current good manufacturing practices; Standard operating procedures, Good laboratory practices (GLPs).	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FQA-246]

Exercise No.	Exercise Title
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
13	Coli form MPN test
14	Sampling of airborne microorganisms
15	Sampling of surfaces - equipment and physical plant
16	Aerosol sampling and measurement guidelines

Suggested Readings [FQA-246]:

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.

Semester	**:**	**IV**	
Course No.	**:**	**FQA-247**	**Credit Hrs. : 2(2+0)**
Course Title	**:**	**Food Quality, Safety Standards and Certification**	

SYLLABUS

Objectives :
(i) To familiarize the students with quality and safety of food and the standards and certification available,
(ii) To understand quality and its assessment,
(iii) To learn different Food Laws and FSMS 22000.

THEORY

Introduction: Definition, its role in food industry, Quality attributes; Quality Defects: Classification, Genetic-physiological defects: Structural, Off color, character; Entomological defects: Holes, Scars, Lesions, Off coloring, Curled aves, Pathological defects; Mechanical defects, Extraneous or foreign material defects. Measurement of defects by different techniques; Quality Assessment: Quality assessment of food materials on the basis of sensory evaluation, Physical, Chemical microbiological methods; Quality of products during processing and after processing: Factors influencing the food qualities: Soil, Field practices, Harvesting practices, Procedures, Packaging, Transportation, Storage, Conditions, Processing conditions, Packaging and Storage conditions of finished products. Role of QC and QA Quality: Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries. Quality Improvement, Total Quality Management: Quality evolution, Quality gurus, Defining TQM, Principals of TQM, Stages in implementation, TQM road map. Quality improvement tools, Customer focus, Cost of quality Food Laws and Standards: National and International food laws Mandatory and Voluntary food laws. FSSAI Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, Food adulteration, Misbranding, Common adulterants in foods, Duties and Responsibilities of Food Safety Authorities AGMARK, BIS, FPO, Weights and Measures Act, CODEX: Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO–standards and certification process, Weights and Measures Act and Packaged commodity rules Role of CODEX in food safety and standards, Food safety issues and risk analysis FSMS 22000 Food Safety Management Systems, ISO22000–2005 and other Global Food safety management systems. Principles, implementation; Documentation, Types of records; Auditing, Certification procedures, Certifying bodies, Accrediting bodies.

TEACHING SCHEDULE

THEORY [FQA-247]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	**Introduction**	Introduction: Definition, its Role in Food industry, Quality attributes	5
2 - 4	**Quality Defects**	Classification, Genetic-physiological defects: Structural, Off colour, 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	10
5 - 7	**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.	10
8 - 10	**Factors influencing the Food Qualities**	Soil, Field practices, Harvesting practices, Procedures, Packaging, Transportation, Storage, Conditions.	5
11 - 13	**Factors influencing the Food Qualities**	Processing conditions, Packaging and Storage conditions of finished products.	5
14 - 16	**Role of QC and QA Quality**	Quality Control, Quality Assurance, Concepts of quality control and Quality assurance functions in food industries.	10
17 - 19	**Quality Improvement; Total Quality Management**	Quality evolution, Quality gurus, Defining TQM, Principals of TQM, Stages in implementation.	5
20 - 22	**Quality Improvement; Total Quality Management**	TQM Road map, Quality improvement tools, Customer focus, Cost of quality.	5

Continued...

23 - 25	**Food Laws and Standards**	National and International Food Laws, Mandatory and Voluntary Food Laws.	5
26 - 28	**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	10
29 - 30	**AGMARK, BIS, FPO, Weights and Measures Act, CODEX**	Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their Certification, FPO–Standards and Certification process Weights and Measures; Act and Packaged Commodity Rules, Role of CODEX in Food safety and standards, Food safety issues and risk analysis.	15
31 - 32	**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.	15
		Total =	**100**

Suggested Readings [FQA-247]:

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 & Sons, Inc., Hoboken. New Jersey, USA.

Semester	**:**	**IV**		
Course No.	**:**	**FPO-241**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Food Plant Utilities and Services**		

SYLLABUS

Objectives :

(i) To gain knowledge of various utilities and services required in a food processing plant,
(ii) To understand working of different services,
(iii)To acquire knowledge of cleaning, maintenance and trouble shooting.

THEORY

Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing; Electrical System- Introduction to electric power supply systems, Electrical billing, Electrical load management and maximum demand control, Power factor improvement and Benefits, Transformers, System distribution losses, Harmonics, Trouble shooting of electrical power system. Electrical motors- Types, Losses in Introduction motor, Motor efficiency, Factors affecting motor performers, Performance, Rewinding and Motor replacement issues, Energy saving opportunities with energy efficient motors. Compressed air system- Requirement, Types, Compressor efficiency, Efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test, Factors affecting the performance and efficiency. Heating, Ventilation and Air Conditioning (HVAC) and Refrigeration system- Requirement, Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factor affecting refrigeration and air conditioning system performance and saving opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with VCR system, Saving potential; Fans and blowers- Requirement, Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities, Pumps and Pumping systems- Requirement, types, Performance evaluation, Efficient system operation, Flow control strategies and Energy conservation opportunities. DG set system- Requirement, Introduction, Factors affecting selection; Fuels and Combustion - Introduction to fuels; Properties of fuel oil, Coal and Gas; Storage; Handling and preparation of fuels; Principles of combustion, Combustion of oil, Coal and Gas; Draft system. Boilers- Boiler specification, Indian boiler regulation, system components, Types, Combustion in boilers, Performance terms, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities; Steam system - Properties of steam, Assessment of steam distribution losses, Steam leakage, Steam trapping, Condensate and flash steam recovery system, Opportunities for energy savings; Waste heat recovery - Classification, Advantages and application, Commercially viable waste heat recovery devices, Saving potential; Other utilities and services- Lighting, Cleaning In Place (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; Water treatment plant; Effluent treatment plant; Fire control operations and use of fire extinguishers.

TEACHING SCHEDULE

THEORY [FPO-241]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1 - 2	**Introduction**	Classification of various Utilities and Services in Food Plant/ Industry. Commercial Energy Pricing	5
3 - 5	**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	10
6 - 8	**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.	10
9 - 11	**Compressed Air System**	Requirement, Types, Compressor efficiency, Efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test, Factors affecting the performance and efficiency.	10
12 - 14	**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.	10
15	**Vapor Absorption Refrigeration System**	Working principle, Types and Comparison with VCR system, Saving potential	5
16 - 17	**Fans and Blowers**	Requirement, Types, Performance evaluation, Efficient system operation, Flow control strategies and Energy conservation opportunities.	5

Continued...

18 - 19	**Pumps and Pumping Systems**	Requirement, Types, Performance evaluation, Efficient system operation, Flow control strategies and Energy conservation opportunities.	5
20	**DG Set system**	Requirement, Introduction, Factors affecting selection	5
21 - 23	**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.	10
24 - 26	**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.	10
27 - 28	**Steam System**	Properties of steam, Assessment of steam distribution losses, Steam leakage, Steam trapping, Condensate and Flash steam recovery system, Opportunities for energy savings;	5
29 - 30	**Waste Heat Recovery**	Classification, Advantages and Application, Commercially viable waste heat recovery devices, Saving potential	5
31 - 32	**Other Utilities and Services**	Lighting, CIP system, Waste water/drainage, Water treatment, Dust removal, Fire protection and Maintenance system.	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FPO-241]

Exercise No.	Exercise Title
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	Pumps types, specification, selection, performance terms and definitions
8	Plant lighting system and their components
9	DG system their specification and selection
10	Combustion of oil, gas and coal
11	Boiler performance terms and assessment
12	Study on cost of steam waste heat recovery devices
13	Studies on waste heat recovery boilers,
14	Heat pumps and Thermo compressor.
15	Visit to water treatment plant and effluent treatment plant.
16	Visit to food industry for demonstration of fire control operations and use of fire extinguishers.

Suggested Readings [FPO-241] :

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

B.Tech. (Food Technology)

#List/ Bouquet of Skill Enhancement Courses (SECs)

[in continuation of the SECs' Syllabi prescribed under I, II & III semesters]

Sr. No.	Course No.	Course Title	Credit Hrs.
Department of Food Technology			
1.	**SEC-xxx**	Introduction to Drying Technology and Dryers	2(0+2)
2.	**SEC-xxx**	Introduction to Processing of Extruded Foods	2(0+2)
3.	**SEC-xxx**	Introduction to Milling (Rice, Dal, Spices, etc.)	2(0+2)
Department of Food Quality Assurance			
4.	**SEC-xxx**	Introduction to Food Safety and Sanitation	2(0+2)
5.	**SEC-xxx**	Introduction to Good Laboratory Practices	2(0+2)
6.	**SEC-xxx**	Basic Food Analysis Laboratory Techniques	2(0+2)
Department of Food Engineering			
7.	**SEC-xxx**	Introduction to Electrical and Control Systems in Food Industry	2(0+2)
8.	**SEC-xxx**	Introduction to Mechanical Systems in Food Industry	2(0+2)
9.	**SEC-xxx**	Introduction to AutoCAD	2(0+2)
Department of Food Plant Operations			
10.	**SEC-xxx**	Maintenance of Food Processing Equipments	2(0+2)
11.	**SEC-xxx**	Introduction to Bottling and Canning Line	2(0+2)
12.	**SEC-xxx**	Introduction to Manufacturing of Bakery Products	2(0+2)

Note: (i) Skill Enhancement Courses can be added/ offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject. ***However, students with exit option have to select/ get offered the SECs as mentioned against the Nomenclature of UG-Diploma and such course(s) is/are to be selected from respective dept./disciplines.**

(ii) Above list/ bouquet of SEC courses is an indicative list and subject to modification as applicable therein.

(iii) In case of unavailability of the detailed course-wise syllabus/ teaching schedules of any of above SEC courses, the same can be primarily developed and followed at College/ University level in the current academic year. However, the same can be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

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Skill Enhancement Courses (SECs): Detailed Syllabi

[*in continuation of the SECs' Syllabi prescribed under I, II & III Semesters*]

Discipline: Food Technology: Department of Food Technology

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Drying Technology & Dryers**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction to drying process and its mechanism
2	Understanding of different methods for moisture estimation
3	Determination of moisture content with oven method
4	Determination of drying characteristics and study of kinetics
5	Prediction of moisture sorption isotherms
6	Determination of equilibrium moisture content of grain
7	Introduction to different dryings theories and its importance
8	Introduction to different methods of drying (contact, convective and radiation).
9	Principle and operational mechanism involved in cabinet and tunnel drying
10	Principle and operational mechanism involved in spray drying
11	Principle and operational mechanism involved in roller/ drum drying
12	Principle and operational mechanism involved in fluidized bed drying
13	Principle and operational mechanism involved in foam-mat drying
14	Principle and operational mechanism involved in microwave drying
15	Principle and operational mechanism involved in vacuum oven drying
16	Principle and operational mechanism involved in solar drying
17	Principle and operational mechanism involved in refractance window drying of foods
18	Study of pretreatment methods for drying and dehydration
19	Study of operational principle and working of freeze dryer
20	Study of Rehydration/ Reconstitution properties of dehydrated foods
21	Drying of fruit slices in cabinet drier
22	Drying of green leafy vegetables
23	Drying of mango/ other pulp by foam-mat drying
24	Drying of foods using roller dryer and spray dryer

Continued...

Introduction to Drying Technology & Dryers….

25	Drying of foods using freeze drying process
26	Preparation of mango leather
27	Preparation of Osmo-dehydrated food products (candied fruits, glazed fruits)
28	Preparation of dehydrated raisins
29	Study of packaging, labeling and FSSAI Regulations of Dehydrated products
30 - 31	Industrial Visit to different dehydration Units.
32	Case study on fruits and vegetable drying

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Processing of Extruded Foods	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction and market survey of extruded products
2	Introduction of food extruders components and their functions
3-4	Principle and operational mechanism involved in cold and hot extruder (Single and Twin-Screw Extruder)
5	Preparation of spaghetti pasta
6	Preparation of penne pasta
7	Preparation of noodles
8	Preparation of vermicelli
9	Preparation of instant noodles
10	Quality evaluation of pasta products
11-12	Demonstration of extrusion products (extruded snacks/ breakfast cereal/ texturized vegetable protein)
13	Preparation of traditional extruded products (sev/ chakli)
14	Evaluation of physical properties of expanded snacks
15	Evaluation of water and milk hydration properties of breakfast cereal
16	Evaluation of functional properties of expanded snacks
17	Evaluation of functional properties of texturized vegetable protein.
18	Preparation of plant-based meat analogue by using extruder
19	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking
20	Preparation of extruded confectionary product
21	Effect of feed moisture content on extrudate food product characteristic
22	Studies on development of weaning food by extrusion technology
23	Texture profile analysis of extruded product
24	Preparation of dietary fiber rich extruded product
25	Quality evaluation of commercially available extruded food products
26	Packaging of extruded products
27	Quality evaluation of different extruded products
28	Determination of techno-economic feasibility of prepared extruded product
29	Sensory evaluation of prepared extruded products
30	Labeling and FSSAI regulations of different extruded products.
31 - 32	Visit to commercial extrusion unit.

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Milling (Rice, Dal, Spices etc.,)	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1	Introduction and market survey of milled rice, dal and spices,
2	Determination of physical properties of rice grain, dal and spices
3	To study the defects in grains and milled rice, dal and spices by physical observation
4	Determination of moisture content in different milled product
5	Studies on traditional methods of milling of dal and rice grains
6	Cleaning of rice, dal and spices for milling
7	Studies on different dehusking and deshelling equipment's involved in the milling of paddy grains
8	Principles and operational mechanism of rice mills
9	Determination of Head Rice Yield (HRY), Milled Rice Yield (MRY) and % brokens.
10	Determination of polishing quality of paddy
11	Studies on different byproducts of paddy milling
12	Studies on different methods and pretreatments involved in pulse milling
13	Studies on dry milling and wet milling of pulses for production of dal
14	Principles and operational mechanism of dal mills
15	Cleaning and inspection for effective grading and sieving of grains based on size and grade.
16	Demonstration of the procedure of cleaning of unprocessed whole spices
17	Principles and operational mechanism spice mills
18	Manufacture of dalia from cereal and legumes
19	Production process of rice from paddy
20	Study on mini dal mill
21	Studies on utilization of byproduct from dal milling industry
22	Preparation of turmeric powder
23	Preparation of curry powder
24	Recipe formulation and preparation of different spice mix powder (Turmeric, Chilli, Onion, Ginger etc.)
25	Sieve analysis of milled products for particle size distribution

Continued...

26	Milling yield calculation for different grains
27	Packaging and storage techniques for milled products
28	Techno-economic feasibility of prepared spice powder and milled dal
29	Case study on spice powder processing industries
30	To study milling quality of rice, dal and spices
31	Study of packaging, labelling and FSSAI regulations of dehydrated products
32	Visit to commercial rice mill, dal mill and spice industry

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Discipline: Food Technology: Department of Food Quality Assurance

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Introduction to Food Safety and Sanitation**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Understanding food safety and sanitation: concept, terms and importance
3 - 4	Developing the process flow for the food establishment including all the inputs, outputs and interim loops
5 - 6	Data collection for identification of biological, chemical and physical hazards
7	Hazard Analysis using FMEA technique for risk assessment
8	Demonstration of correct method of washing hands
9 - 10	Assessment of personal hygiene
11 - 12	Identifying the key focus areas for GHP and GMP
13 - 14	Identifying gaps in its implementation; closure plans for identified gaps
15 - 16	Importance of temperature control and demonstrating proper cooking, cooling and reheating temperatures using thermometers
17	Introduction to HACCP
18 - 19	Development of OPRP (Operational Pre-requisite Programme) and Development of HACCP Plan (Critical Limits including Rationale for Limits)
20 - 21	Monitoring procedure, correction and corrective measures
22 - 23	Introduction to cleaning agents and techniques for sanitizing surfaces
24 - 25	Hands-on Demonstration of using chemical sanitizers correctly
26 - 27	To recognize signs of pest infestations and methods of control
28 - 29	Demonstration of segregation of waste
30 - 31	To study proper disposal methods for different types of waste
32	Practice identifying common food allergens and labeling

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Good Laboratory Practices	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Introduction and importance of good laboratory practices
3 - 4	Practical session on identifying hazards and using appropriate personal protective equipment
5 - 6	Hands-on practice with common lab equipment (e.g. microscopes, pipettes, balances, centrifuges etc.)
7 - 8	Equipment calibration techniques and how to properly maintain instruments
9 - 10	Techniques for cleaning, drying and sterilizing lab glassware to prevent contamination
11 - 12	Autoclave operation for sterilization, calibration of balances, pH meters and spectrophotometers
13 - 14	Sample collection techniques for biological, chemical or environmental samples
15 - 16	Correct labeling and storage procedures to maintain integrity
17 - 18	Proper segregation and disposal of hazardous and non-hazardous lab waste
19 - 20	Understanding chemical compatibility and safe disposal practices
21 - 22	Performing basic quality control tests like titration, pH measurement and UV-Vis Spectrophotometry to assess the purity and quality of samples
23 - 25	Aseptic techniques for handling microbial cultures, preparing agar plates and transferring cultures
26 - 28	Detecting, recording and reporting errors or deviations in experimental work
29 - 30	Writing and following SOPs for basic lab techniques like, solution preparation or instrument usage

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Basic Food Analysis Laboratory Techniques	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Sampling plan; Sample collection and preparation for analysis
3 - 4	Sensory evaluation techniques of food products
5 - 6	Quality evaluation of food products for color and taste of marketed products
7 - 8	Determination of moisture content in food samples
9 - 10	Water analysis
11 - 12	Determination of ash content in food samples
12 - 13	Determination of crude fat in food samples
14	Determination of crude protein in food samples by Kjeldahl method
15 - 16	Determination of crude fibre in food samples
17	Qualitative tests for sugars
18 - 19	Qualitative tests for proteins, Colorimetric estimation of protein concentration
20 - 21	Estimation of total and reducing sugars
22 - 23	Measuring the pH of various food samples like fruits, dairy, and beverages
24 - 25	Determining the acidity in food samples by titrating with a base
26 - 27	Determination of Total Soluble Solids and Vitamin C in food samples
28	Determination of Salt Content in food samples
29 - 30	Estimation of chlorophyll and carotenoids in food samples
31	Estimation of Macro and Micro minerals
32	Visit to NABL-Accredited Food Laboratory

Discipline: Food Technology: Department of Food Engineering

Course No.	**: SEC-xxx**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**: Introduction to Electrical and Control Systems in Food Industry**		

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Build simple electrical circuits using resistors, capacitors and inductors
3	Measurement of voltage, current and resistance using a multimeter
4 - 5	Explore different types of sensors used in food processing
6 - 7	Performing calibration exercises with EC/pH meter. Study of different types of motors (AC, DC, Stepper) and their applications
8 - 9	Developing a motor control circuit for a conveyor system
10 - 11	Programming simple control sequences using PLC software
12	Creating a basic ladder logic diagram for a conveyor belt system
13	Simulating PID control for a temperature control system
14 - 15	Designing a simple HMI using software tools (like Factory Talk or WinCC)
16 - 17	Integrating the HMI with PLC for monitoring and control
18 - 19	Setting-up a small SCADA system for monitoring a food processing operation
20 - 21	Understanding data logging and visualization techniques
22	Learning about industrial communication protocols (Modbus, Ethernet/IP)
23 - 24	Creating a simple network setup to connect PLCs and HMIs
25	Building and analyze a control loop for a food processing scenario (e.g. Pasteurization)
26	Understanding feedback mechanisms and their importance in control systems
27	To diagnose and troubleshoot faulty electrical circuits
28	To develop systematic approaches to identify common issues
29	To measure and analyze energy consumption in a small-scale food processing set-up
30	To explore energy-saving practices and technologies in the industry
31	Safety protocols in electrical systems
32	Visit to Food Industry for practical exposure of electrical and control system

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Mechanical Systems in Food Industry	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Introduction to mechanical system and its application in food industry
3 - 4	To identify and understand the function of basic mechanical components (gears, belts, pulleys, bearings) used in food machinery
5 - 6	To study different materials used in food machinery and their properties
7 - 8	To practice the assembly and disassembly of simple food processing machines (e.g., mixers, blenders)
9 - 10	To measure and analyze vibration in food processing equipment
11 - 12	To learn how to identify issues such as misalignment or imbalance
13 - 14	To perform routine maintenance tasks on mechanical systems (lubrication, belt tensioning)
15 - 16	To conduct troubleshooting exercises to identify and fix common mechanical failures
17	Study of principles, construction and working of cleaning equipments
18	Study of principles, construction and working of sorting/grading equipments
19	Study of principles, construction and working of washing equipments
20	Study of principles, construction and working of handling equipments
21	Study of principles, construction and working of food packaging machines
22 - 23	To conduct tests to evaluate corrosion resistance and suitability for food contact
24 - 25	To explore the use of robotic systems for tasks such as packing or palletizing
26 - 27	To implement quality control measures in a mechanical process (e.g. measuring dimensions of food products)
28 - 29	To create basic mechanical drawings using CAD software
30 - 31	Project work to enlist various mechanical parts and its functionality in different food processing industries
32	Visit of food industry to identify mechanical systems in food processing

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to AutoCAD	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Introduction to AutoCAD and its application in the food processing industry
3 - 4	Familiarization with the AutoCAD interface: toolbars, menus and command line
5	Practice using drawing tools to create geometric shapes
6 - 7	Experiment with drawing precision using grid and snap features
8	Learning to modify objects using commands such as move, copy, rotate, scale and mirror
9	To perform exercises on editing shapes and lines in an existing drawing
10	To create and manage layers in a drawing
11	To assign different colours and line types to layers for better organization
12	To add linear, radial and angular dimensions to drawings
13 - 14	To practice dimensioning techniques and understand best practices for clarity
15	To insert text and annotations into a drawing
16	To explores tyles and formatting options for clarity and presentation
17 - 18	To draw a complete 2D engineering drawing of an equipment
19	Introduction to 3D modeling: create basic 3D shapes (cubes, cylinders)
20 - 21	To practice using 3D viewing tools and rendering techniques
22 - 23	Setting-up a layout for printing: scaling, title blocks and viewports
24 - 25	Understanding the file types and compatibility issues (DWG, DXF) to save the AutoCAD files
26	To attach and manage external references in a drawing
27 - 28	To develop a detailed plan (floor plan, mechanical part) incorporating multiple elements
29 - 30	To create isometric drawings to represent three-dimensional objects in two dimensions
31 - 32	To practice isometric dimensioning and labeling

Discipline: Food Technology: Department of Food Plant Operations

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Maintenance of Food Processing Equipments**			

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Hands on identification of various types of food processing equipment
3 - 4	Creation of customized preventive maintenance check lists for different equipment
5 - 6	Simulated execution of a preventive maintenance routine
7	Understanding the types of lubricants used in food processing
8	Practicing proper lubrication techniques on machinery
9 - 10	Learning about different cleaning agents and their appropriate use
11 - 12	Conducting cleaning protocols on equipment incompliance with food safety standards
13 - 14	Practical exercises in electrical trouble shooting, including circuit testing and voltage measurement
15 - 16	Dismantling and reassembling parts of common food processing equipment
17 - 18	Simulated troubleshooting of common equip mental functions
19 - 20	Simulating the documentation of maintenance activities and creating maintenance logs
21	Study of maintenance of cleaning equipment
22 - 23	Study of care and maintenance of sorting/ grading equipment
24 - 25	Study of care and maintenance of milling equipment
26 - 27	Study of care and maintenance of drying equipment
28 - 29	Study of care and maintenance of material handling equipment
30 - 31	Study of care and maintenance of packaging equipment
32	Study of care and maintenance of storage units

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Bottling and Canning Line	

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1 - 2	Introduction to bottling and canning process
3	Study of sorting and grading equipments
4	Study of washing equipments
5	Study of peeling methods and equipments
6	Study of cutting equipments
7	To perform the blanching of fruits and vegetables
8	To check the adequacy of blanching process
9 - 10	Study of different types of bottles and cans, including materials and sizes
11	Study of different filling techniques (gravity, pressure, vacuum)
12	Practical session on filling bottles/cans accurately
13	Cut out analysis of cans
14	Hands-on practice on in-bottle sterilization
15	Hands-on practice with various sea ling methods(screw caps, corks, can lids)
16	Testing seal integrity using various methods
17	Practical session on labeling machinery operation
18	Coding and printing best practices for product information
19	Conduct quality checks on filled and sealed products
20	Discuss common quality issues and troubleshooting techniques
21	Study of domestic carbonator and carbonation process
22	Learn proper cleaning and sanitation protocols for equipment
23 - 24	Hands-on cleaning sessions for different parts of the line
25	Basic maintenance tasks for key equipments
26	Troubleshooting common problems in bottling and canning lines
27	Workshop on regulations affecting bottling and canning
28	Product handling and storage
29	Practical session on proper storage techniques
30 - 31	Study of packaging, labeling and FSSAI regulations of beverages and canned products
32	Visit to beverage and canning industry

Course No. : SEC-xxx	Credit Hrs. : 2(0+2)
Course Title : Introduction to Manufacturing of Bakery Products	

TEACHING SCHEDULE

PRACTICAL [SEC-xxx]

Exercise No.	Exercise Title
1 - 2	Introduction and market survey of bakery products
3 - 4	Study of different methods of preparation of bakery product (bread, biscuit, cake and cookies etc.)
5 - 6	Determination of gluten content in Wheat flour
7 - 8	Determination of sedimentation value of Wheat flour
9 - 10	Determination of Pelshenke value of Wheat flour
11 - 12	Determination of water and oil absorption of flour
13 - 14	Determination of emulsion capacity and stability of flour
15 - 16	Determination of foaming capacity and stability of flour
17 - 18	Determination of alkaline water retention capacity of flour
19 - 20	Preparation and quality evaluation of composite formulation of Wheat-based cookies
21 - 22	Preparation and quality evaluation of Millet-based cookie formulations
23 - 24	Preparation and quality evaluation of crackers
25 - 26	Preparation and quality evaluation of unleavened flat breads
27 - 28	Preparation and quality evaluation of leavened breads (White bread, Brown bread)
29	Preparation and quality evaluation of cake/muffin
30	Preparation and quality evaluation of baked cereal bar
31	Study of packaging, labeling and FSSAI regulations of bakery products
32	Visit to Commercial Bakery Unit