SEMESTER WISE COURSE STRUCTURE
&
EVALUATION SCHEME

B. Tech. FOOD TECHNOLOGY
(Effective from the session 2022-23 for new entrants)

HARCOURT BUTLER TECHNICAL UNIVERSITY
KANPUR-208002 (UP) – INDIA

HARCOURT BUTLER TECHNICAL UNIVERSITY

DEPARTMENT OF CHEMICAL TECHNOLOGY - FOOD TECHNOLOGY

SCHOOL OF CHEMICAL TECHNOLOGY

THE UNIVERSITY

VISION

"To achieve excellence in technical education, research and innovation"

MISSION

1. ***Imparting Knowledge to develop analytical ability in science and technology to serve the industry and society at large.***

2. ***Equip and enable students with conceptual, technical and managerial skills to transform the organization and society.***

3. ***Inculcating entrepreneurial philosophy and innovative thinking to promote research, consultancy and institutional social responsibility.***

4. ***Serving people, society and nation with utmost professionalism, values and ethics to make development sustainable and quality of life.***

THE DEPARTMENT

VISION

"To develop technically sound food technocrats, to cater the needs of food processing industries, Research & Development organizations and society"

MISSION

The missions of the Department of Food Technology are:

- ***M1 : Imparting technical knowledge to develop human resources for food processing sectors.***
- ***M2 : Imparting knowledge & technical skills for better processing and value addition of Food &Agro-products through R&D.***
- ***M3 : Inculcating innovative thinking with the aim to support entrepreneurship and to develop state-of-art technologies for testing and consultancy to fulfill the needs of industry and society.***
- ***M4 : Cultivating strong ethical values for sustainable modern and safe food to society.***

I. Program Educational objectives (PEOs) for B. Tech. Chemical Technology-Food Technology

The educational objectives of B. Tech. Chemical Technology - Food Technology program are:

PEO1:	Graduates of the program will contribute to the development of sustainable growth of food processing sector for the betterment of society
PEO2:	Graduates of the program will accept and create innovations in providing solution for sustainable technological development
PEO3:	Graduates of the program will meet challenges in terms of quality assurance and standardization to withstand the global competitiveness
PEO4:	Graduates of the program will exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning for betterment of society

Consistency of PEOs with Mission of the Department

PEO Statements		**M1**	**M2**	**M3**	**M4**
PEO1:	Graduates of the program will contribute to the development of sustainable growth of food processing sector for the betterment of society	3	3	2	1
PEO2:	Graduates of the program will accept and create innovations in providing solution for sustainable technological development	3	2	2	1
PEO3:	Graduates of the program will meet challenges in terms of quality assurance and standardization to withstand the global competitiveness	3	2	2	1
PEO4:	Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning for betterment of society	2	2	2	3

<u>Program Outcomes (POs) of B. Tech. Chemical Technology - Food Technology</u>

Graduating Students of B. Tech. Chemical Technology - Food Technology program will be able to:

Program Outcomes (POs)		**Graduate Attributes(GAs)**
PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	Engineering Knowledge

PO2	Identify, formulate, review research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	Problem Analysis
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	Design/Development of solutions
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	Conduct Investigations of complex problems
PO5	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	Modern Tool Usage
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	The Engineer & world
PO7	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	Ethics
PO8	Function effectively as an individual, and as a	Individual and team work

	member or leader in diverse teams, and in multidisciplinary settings.	
PO9	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Communication
PO10	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Project management and finance
PO11	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	Life-long learning

Program Specific Outcomes (PSOs) for B. Tech. Chemical Technology - Food Technology program are:

Graduating students of B. Tech. Chemical Technology - Food Technology program will be able:

PSO1	to apply practical skills, technical knowledge in major streams such as chemistry, manufacturing, processing, and to application areas of engineering & technology in food industries
PSO2	to take-up career in research organizations and to pursue higher studies in food technology and interdisciplinary programs with high regard for ethical values, environmental and social issues.

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR
SCHOOL OF CHEMICAL TECHNOLOGY
DEPARTMENT OF FOOD TECHNOLOGY
Semester wise Course Structure
B. Tech. Chemical Technology - Food Technology
(Applicable from Session 2022-2023 for new entrants)
Year I, Semester-I

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Physics	NPH-101	4	3	0	2	15	20	15	50	50	100
2	BSC	Engineering Mathematics-I	NMA-101	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electrical Engineering	NEE-101	4	3	0	2	15	20	15	50	50	100
4	ESC	Introduction to Mechanical Engineering	NME-101	4	3	1	0	30	20	-	50	50	100
5	HSMC	Professional Communication	NHS-101	4	2	1	2	15	20	15	50	50	100
6	ESC	Engineering Graphics	NCE-103	2	0	0	4	30	20	-	50	50	100
	Total Credits: 22												**600**

(Applicable from Session 2022-2023 for new entrants)
Year I, Semester-II

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Chemistry	NCY-102	4	3	0	2	15	20	15	50	50	100
2	ESC	Introduction to Computer Science &Engineering	NCS-102	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electronics Engineering	NET-102	4	3	1	0	30	20	-	50	50	100
4	ESC	Introduction to Civil Engineering	NCE-102	4	3	1	0	30	20	-	50	50	100
5	ESC	Introduction to Chemical Engineering& Chemical Technology	NCT-102	4	3	1	0	30	20	-	50	50	100
6	ESC	Workshop Practice	NWS-102	2	0	0	4	-	20	30	50	50	100
	Total Credits: 22												**600**

(Applicable from Session 2023-2024)
Year II, Semester-III

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Mathematics-II	NMA-201	4	3	1	0	30	20	-	50	50	100
2	ESC	Fluid Mechanics and Mechanical Operations	NCT-201	4	3	0	2	15	20	15	50	50	100
3	PCC	Fundamentals of Food Science and Human Nutrition	NFT-201	4	3	1	0	30	20	-	50	50	100
4	PCC	Microbiology and Biochemistry of Food	NFT-203	4	3	1	0	30	20	-	50	50	100
5	PCC	Chemical Process Calculations	NCT-203	3	3	0	0	30	20	-	50	50	100
6	HSMC	Economics& Management	NHS-201	3	3	0	0	30	20	-	50	50	100
7	PCC	Food Analysis Lab	NFT 205	2	0	0	4	-	20	30	50	50	100
	Total Credits: 24												**700**

(Applicable from Session 2023-2024)
Year II, Semester-IV

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Modern Analytical Techniques	NCY-202	4	3	0	2	15	20	15	50	50	100
2	ESC	Computer Oriented Numerical Methods	NMA-204	4	3	0	2	15	20	15	50	50	100
3	PCC	Food Chemistry	NFT-202	4	3	1	0	30	20	-	50	50	100
4	PCC	Chemical Engineering Thermodynamics	NCT-204	4	3	1	0	30	20	-	50	50	100
5	PCC	Heat Transfer Operations	NCT-202	3	3	0	0	30	20	-	50	50	100
6	PCC	Principles of Food Preservation	NFT-204	3	3	0	0	30	20	-	50	50	100
7	PCC	Food Chemistry Lab	NFT-206	2	0	0	4	30	20	-	50	50	100
	Total Credits: 24												**700**

(Applicable from Session 2024-2025)
Year III, Semester-V

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Technology of Animal & Milk Products	NFT-301	4	3	0	2	15	20	15	50	50	100
2	PCC	Technology of Cereals, Pulses and Oilseeds	NFT-303	4	3	1	0	30	20	-	50	50	100
3	PCC	Fruits, Vegetable and Plantation Products	NFT-305	3	3	0	0	30	20	-	50	50	100
4	PCC	Mass Transfer Operations	NCT-307	3	3	0	0	30	20	-	50	50	100
5	PCC	Chemical Reaction Engineering	NCT-309	3	3	0	0	30	20	-	50	50	100
6	PCC	Food Processing Lab	NFT-307	3	0	0	6	-	20	30	50	50	100
7	HSMC	Entrepreneurship Development	NHS-301	2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**700**

(Applicable from Session 2024-2025)
Year III, Semester-VI

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Instrumentation & Process Control	NCT-302	4	3	0	2	15	20	15	50	50	100
2	PCC	Food Safety and Quality Control	NFT-302	4	3	0	2	15	20	15	50	50	100
3	PCC	Fermented Foods & Beverage Technology	NFT-304	3	3	0	0	30	20	-	50	50	100
4	PCC	Food Packaging & Storage Engineering	NFT-306	3	3	0	0	30	20	-	50	50	100
5	PCC	Advance Food Instrumentation Lab	NFT-308	3	0	0	6	-	20	30	50	50	100
6	PEC-I	Program Elective –I 1. Process Equipment Design 2. Process Modeling & Simulation 3. Process Optimization	NCT-322 NCT-324 NCT-326	3	3	0	0	30	20	-	50	50	100
7	OEC-I	Basic Concepts of Food Processing & Preservation	OFT-302	2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**700**

(Applicable from Session 2025-2026)
Year IV, Semester-VII

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-II	**Program Elective-II** 1. Nutraceutical & Functional Foods 2. Speciality Foods 3. Flavour Technology	NFT-401 NFT-403 NFT-405	4	3	1	0	30	20	-	50	50	100
2	PEC-III	**Program Elective-III** 1. Food Processing Waste Management 2. Food Supply chain Management 3. Total Quality Management	NFT-407 NFT-409 NFT-411	3	3	0	0	30	20	-	50	50	100
3	PEC-IV	**Program Elective-IV** 1. Food Product and Process Development 2. Food Traceability, authenticity & Recall 3. Food Plant Design & Layout	NFT-413 NFT-415 NFT-417	3	3	0	0	30	20	-	50	50	100
4	Industrial Training	Industrial Training	NFT-419	2	0	0	4	-	20	30	50	50	100
5	OEC-II	Nutritional aspects of Natural & Processed Foods	OFT-401	2	2	0	0	30	20	-	50	50	100
6	Minor	Minor Project	NFT-421	6	0	0	12	-	20	30	50	50	100

	Project												
7	Seminar	Seminar	NFT-423	2	0	0	4	-	50	-	50	50	100
	Total Credits: 22												**700**

(Applicable from Session 2025-2026)
Year IV, Semester-VIII

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-V	**Program Elective-V** 1. Innovative Techniques in Food Processing 2. Application of Computer in Food Processing 3. Nano Technology in Food Applications	NFT-402 NFT-404 NFT-406	4	3	1	0	30	20	-	50	50	100
2	OEC-III	Fundamentals of quality and packaging of foods	OFT-402	2	2	0	0	30	20	-	50	50	100
3	Project	Project	NFT-410	16	0	0	24	-	100	100	200	200	400
	Total Credits: 22												**600**

NFT-201: Fundamentals of Food Science and Human Nutrition

L	T	P	C
3	1	0	4

Course objectives: The objective of the course is to impart

- The knowledge about basic concepts of food technology and recent trends of food processing industries in India.
- The knowledge about role of food in human nutrition and protection from various ailments.
- The knowledge about basic biology, chemistry, microbiology and biochemistry of foods.

Course outcomes: On the successful completion of the course, students will be able to

CO1	Understand the status and opportunities in Indian and global Food Industries	Understanding
CO2	Understand the chemical composition of various foods and basic concepts of food processing and preservation.	Understanding
CO3	Understand fundamentals of human nutrition and prevention of human beings from various ailments.	Understanding
CO4	Understand the basics concepts related with microbiological aspects of Food.	Understanding
CO5	Understand the role of Biochemistry in Food.	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	1	1	-	-	-	1	1	-	-	-	1	2	3
CO2	3	1	1	1	-	1	1	-	-	-	2	3	3
CO3	3	-	-	-	1	-	1	-	-	1	1	1	1
CO4	3	1	-	-	-	1	1	1	-	-	2	2	2
CO5	3	1	-	-	-	1	1	-	1	-	2	2	2
Average	3	1	1	1	1	1	1	1	1	1	1.6	2	2.2

1: Slight(Low) 2:Moderate (Medium) 3:Substantial(High) *If there is no correlation, put "-"*

Syllabus

Module-I: Introduction to Food Technology, Its Scope, Opportunities & Challenges

Status of food processes industry in India and globally, Factors affecting the growth of Indian food industries, Opportunities and challenges in Indian food industry, Market scenario of various segments of food industry, Scope and Job opportunities for food technologists

Module-II: Composition of Foods

Definition, classification and functions of foods, constituents of food, , Food spoilage, causes of spoilage, Basics about food preservation, Desirable and potentially undesirable food constituents and their importance, General causes of loss of nutrients during processing and storage.

Module-III : Concept of Food Nutrition and Human Health

Human nutrition and health, Recommended Dietary Allowances, Factors affecting bioavailability of nutrients, Enrichment, Fortification, Restoration and Supplementation of foods, Digestion and absorption of bio-molecules, common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc., Nutritive value and its assessment.

Module-IV: Basic biology &Microbiological Aspects of Food

Living cells, organization of living system, characteristics, Plant and animal diversity, Basics about general microbiology: Culture, media and their types, features of growth in nutrient broth and agar, Staining techniques, Culture preservation techniques, Characterization, classification and identification of microorganisms, Microscopy, Morphology and Structure, Growth, Reproduction and Cultivation of microorganisms, Pure culture and its isolation, Control of microorganisms. Role of microorganisms in food spoilage and preservation

Module-V: Role of Biochemistry in Food

Bioenergetics, Energy transformation in living cells, metabolic pathways, Regulation and Control

Reference Books and Suggested Readings:

Title	**Author**
Agriculture Survey of India	The Hindu

Nutritive value of Indian Foods	C. Gopalan
Food Chemistry	L.H. Mayer
Quality control for Food Industry	Kramner & Twigg
Food facts and Principles.	Manay N.S. Shadakshasawamy M
Microbiology	M.J.Pelczar
Principle of biochemistry	A.L.Lehninger

NFT-203: Microbiology and Biochemistry of Food

L	T	P	C
3	1	0	4

Course objectives: The objective of this course is to impart

- Knowledge of the characteristics of spoilage, pathogenic and food borne infections microorganisms in foods and identifying the ways to control them during processing, preservation, storage, transportation and marketing of foods.
- Knowledge about food plant sanitation and ensure about food safety to the consumers.
- Knowledge of engineering principles applied in post-harvest technology with particular reference to horticulture produce.
- Understanding and ability to control the major chemical and biochemical reactions that influence food quality with emphasis on food industry applications.
- Knowledge of animal tissues and biochemical reactions responsible for quality of the food.

Syllabus: On the successful completion of the course, students will be able to

CO1	Understand the environmental factors affecting microbiological stability /spoilage and techniques by which the important pathogens and spoilage microorganisms are commonly inactivated, killed or made harmless in foods.	Understanding
CO2	Understand the characteristics of foodborne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification and the microbiology of different types of food commodities	Understanding
CO3	Understand the necessity of food safety, plant sanitation and control of hazards in food processing.	Understanding
CO4	Understand the basic post-harvest physiology and consequences during handling of fresh produces and the facilities and techniques of treatment & storage of fruit and vegetables.	Understanding
CO5	Understand the major biochemical reactions that affects the quality of Meat and meat products. Role of enzymes in food processing industry	Understanding

CO-PO Mapping

COs	POs											PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2	1	1	2	-	1	-	-	-	-	1	3	3
CO2	3	2	1	-	1	1	-	1	-	-	2	2	2
CO3	3	1	-	-	1	2	1	-	-	1	2	3	3
CO4	2	1	-	-	-	2	-	-	1	-	2	3	3
CO5	3	2	1	1	-	1	-	-	-	-	2	3	3
Average	**2.6**	**1.4**	**1**	**1.5**	**1**	**1.4**	**1**	**1**	**1**	**1**	**1.8**	**2.8**	**2.8**

1:Slight (Low) 2:Moderate(Medium) 3:Substantial(High) *Ifthereisnocorrelation,put"-"*

Syllabus

Module-I: Microorganisms in Foods, Spoilage and Preservation

Incidence of microorganisms in foods, Primary sources of contamination in foods, Intrinsic and Extrinsic parameters of foods that affect microbial growth, Food Spoilage, Causes of Food spoilage, Food Preservation, Principles underlying preservation of foods, Methods of food preservation, Fitness of foods, Determination of thermal resistance of bacterial spores, Radiation-resistant bacteria, Mechanism of action of antimicrobial agents

Module–II: Food Poisoning, Spoilage and Preservation of Various Food Products

Food poisoning and food-borne infections, Screening, detection and enumeration techniques including rapid detection techniques for Food Micro-organisms including pathogens. Contamination, spoilage and preservation of Fruit and Vegetable products, Milk and Milk products, Cereal products, Sugar products, , Meat products, Fish and Sea foods, Egg and Poultry products and other foods.

Module-III: Food Safety, Plant Sanitation & HACCP

Indicators of Food Safety and Quality, Microbiological Standards of foods, Food Plant Sanitation, inspection and control, Personnel Hygiene, HACCP in Food Industry in controlling microbial hazards, Beneficial microorganisms and their utilization in food fermentation, Introduction to abiotic, biotic and probiotics.

Module-IV: Post Harvest physiology, Handling and Storage of Fruits and Vegetables

Structure and composition of fruit and vegetables: Definition, cellular components, chemical composition and nutritional value. Physiology and biochemistry of fruit and vegetables: Post-harvest handling, physiological development; growth, maturation and senescence, fruit ripening, physiology of respiration, effect and role of ethylene, biochemistry of respiration; aerobic and anaerobic metabolism, chemical changes during maturation. Control atmosphere storages, effect of temperature, water loss and humidity,

methods for modifying carbon dioxide and oxygen concentration, physiological disorders: low temperature disorders.

Module-IV: Biochemistry of Meat and Enzymes in Food industry

Structure and growth of muscle, chemical and biochemical constitution of muscle, ante-mortem and post-mortem factors affecting quality of meat, Biochemical reactions leading to changes in composition, color, flavour and texture of meat. Application of enzymes in food processing: Endogenous enzymes and their role in modification of foods, enzyme added to foods during processing sources, conversions and specific applications.

Reference Books and Suggested Readings

Title	Authors
Modern Food Microbiology	James M.J.
Food Microbiology	FrazierW.C. & Westhoff D.C.
Food Microbiology	Adam M. R. & Moss M.O.
Food Microbiology	Roberts D. & Greenwood M.

NFT-205: Food Analysis Lab

L	T	P	C
0	0	4	2

Course objectives: The objective of this course is to impart

- Knowledge to utilize laboratory techniques to detect, quantify, and identify microorganisms in foods.
- Knowledge to determine the chemical composition of various foods experimentally.
- Knowledge for kinetic study of enzymes in biochemical reactions of foods.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Determine the best microbiological laboratory practices and evaluate microbial data for food analysis.	Applying
CO2	Determine the basic composition of foods experimentally	Applying
CO3	Calculation of Km with the study, the effect of substrate concentration, temperature and pH on enzyme activity.	Applying

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2	1	1	2	-	2	1	1	2	1	1	3	3
CO2	3	2	1	1	-	1	1	2	2	1	2	2	2
CO3	3	1	1	1	1	2	1	2	2	1	2	3	3
Average	**2.6**	**1.3**	**1**	**1.3**	**1**	**1.6**	**1**	**1.6**	**2**	**1**	**1.6**	**2.6**	**2.6**

1:Slight (Low) 2:Moderate(Medium) 3:Substantial(High) *If there is no correlation,put "-"*

	Laboratory Experiments	No of periods
1	Microscope its parts and utility in identification and differentiation of bacteria, yeast and mold.	03
2	Familiarization with Culture, Inoculation, Incubation, features of growth and slide preparation, Wet mount preparation, staining with basic dye and Gram staining.	03
3	Cell size measurement, total cell count	03

4	Preparation and sterilization of media and glass ware for microbial counts.	03
5	Introduction to Food Analysis techniques.	03
6	Sampling techniques and method of sample preparation.	03
7	Determination of moisture content of foods.	03
8	Determination of Total and Acid insoluble ash content in foods.	03
9	Determination of Crude fat content by solvent extraction methods in foods.	03
10	Determination of crude Protein in foods by Kjeldhal methods.	06
11	Determination of reducing and total sugar content in foods.	06
12	Determination of crude fibre content in foods.	03
13	Determination of specific vitamin content of food such as ascorbic acid.	03
14	Chromatographic Separation and identification of sugars and amino acids.	03
15	Determination of nutritive value of foods	03
16	Effect of substrate concentration on enzyme activity	03
17	Effect of temperature on enzyme activity	03
18	Effect of pH on enzyme activity	03
19	Analysis of foods for pesticides.	06
20	Determination of various adulterants in foods.	03
Total Hours		**69**

NFT-202: FOOD CHEMISTRY

L	T	P	C
3	1	0	4

Course objectives: The objectives of this course are to impart

- Knowledge on innate properties of food molecules and their interactions with other food constituents
- The knowledge of food additives and their applications in food processing
- Understanding of analytical techniques for identification and quantification of various biomolecules present in the food

Course out comes: On the successful completion of the course the students will be able to

CO1	Understand the chemistry of water and carbohydrate and thei interaction with other food components	Understanding
CO2	Understand the basic structure of lipid and reaction involved durin processing	Understanding
CO3	Understand the chemistry and properties of food proteins an modification of food proteins during processing	Understanding
CO4	Understand the sources and their deficiency during processing and apply the knowledge to minimize their losses during processing	Applying
CO5	Discuss the functionality of food additives and their application in food industry	Applying

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	3	1	-	-	-	-	-	-	-	-	1	3	3
CO2	3	1	-	-	-	-	1	-	1	-	1	3	3
CO3	3	2	-	-	1	-	-	2	-	-	1	3	3
CO4	3	2	1	1	-	1	-	-	-	1	1	3	3
CO5	3	2	1	-	-	1	-	-	-	-	1	3	3
Average	**3**	**1.6**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**3**	**3**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put "-"*

Syllabus

Module-I: Water and Carbohydrate
Water in Foods: Structure, Properties, Interactions, Water activity and sorption isotherm, Molecular mobility and food stability
Carbohydrates: Classification, Functions, Reactions and properties of simple and complex carbohydrate, Selection of Natural or Modified carbohydrates for incorporation into processed food.

Module-II: Lipids
Classification, Consistency of commercial fat, Lipolysis,Autooxidation,Thermal decomposition and effect of ionizing radiation, Refining of oils, Modification of oils and fats, Role of food lipids in flavor, Nutritional and safety aspects of natural and modified fats.

Module-III: Proteins
Classification, nutritional and functional properties of food proteins, Nutritive value and its determination, Chemical reactions and interactions of amino acids and proteins, De-naturation and its implications, Functional properties of food proteins, Modification of food proteins in processing and storage and its implications.

Module-IV:Vitamins, Minerals, Pigments and Flavors
Vitamins, Minerals, Pigments and Flavors:Sources, Functions, Deficiency diseases, Chemistry and stability of water and fat-soluble vitamins during processing, Chemical properties of minerals and their bioavailability, Enrichment and fortification. Natural pigments in foods and their retention in processed foods, Flavoring constituents in foods, Development of process and reaction of flavor volatiles.

Module-V:Food Additives
Definitions, sources, uses and functions and regulatory aspects of food additives

ReferenceBooks and SuggestedReadings:

Title	**Author**
Food Chemistry	O.R. Fennema
Food Facts and Principal	N. Shakuntala Manay& M. Shadaksharaswamy
Food Chemistry	L.H. Meyer
Food Chemistry	H.D. Belitzand W. Grosch
Food Additives	S.N. Mahindru
Hand book of analysis and quality control for fruits and vegetable products	S. Ranganna

NFT-204: PRINCIPLES OF FOOD PRESERVATION

L	T	P	C
3	0	0	3

Course Objectives: The objective of this course is to impart

- Knowledge of basic principles in food preservation.
- Knowledge of processing methods to control food spoilage and deterioration
- Knowledge of equipment used in food processing for value addition

Course Outcomes: Upon the successful completion of the course, the student will be able to

CO1	Understand fundamental principles of food preservation	Understanding
CO2	Understand the principles of low-temperature preservation	Understanding
CO3	Understand the principle of thermal processing and applying high-temperature processing in the food industry	Applying
CO4	Understand the concept of water activity and preservation by reduction of water removal	Understanding
CO5	Understand the principles of non-thermal preservation methods	Understanding

CO-PO Mapping

COs	POs											PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	3	1	-	1	-	1	-	-	-	-	1	3	3
CO2	3	2	-	1	-	1	-	-	1	-	1	3	3
CO3	3	2	-	1	1	1	1	-	-	-	1	3	3
CO4	3	2	-	1	-	1	-	1	-	1	1	3	3
CO5	3	2	1	-	-	-	-	-	-	-	1	3	3
Average	**3**	**1.8**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**3**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put "-"*

Syllabus

Module-I: Introduction and need for food preservation

Aims and objectives of preservation of foods, Degree of perishability of unmodified foods, Causes of quality deterioration and spoilage of perishable foods: Microbial, Physical, Chemical & Miscellaneous, wastage of foods. Concept of Water activity, Intermediate moisture Food, osmosis, and diffusion

Module – II: Preservation of foods by low temperatures

Chilling temperatures: Consideration relating to storage of foods at chilling temperatures, Applications, and procedures, Controlled and Modified atmosphere storage of foods, Post storage handling of foods. Freezing temperatures: Freezing process, slow and fast freezing of foods and its consequence, and other occurrences associated with freezing of foods. Technological aspects of pre-freezing, Actual freezing, Frozen storage, and thawing of foods,

Module –III: Preservation of foods by high temperatures

Basic concepts. Lethality requirement and assessing the adequacy of a thermal process: D value, Z Value, F value etc., Blanching, Pasteurization: Batch and continuous. Commercial sterilization of foods: Conventional canning process, batch and continuous retorts, aseptic processing.

Module – IV: Preservation by water removal

Food concentration: Principles, Technological aspects, and application of evaporative concentration process; Freeze concentration and membrane process. Drying and dehydration of foods: Principles, Technological aspects, and application. Types of dryers: Cabinet, tunnel, belt, bin, drum, spray, vacuum, foam mat, fluidized-bed, and freeze drying of foods.

Module – V: Preservation by Non-thermal methods

Principles, Technological aspects and application of sugar and salt, Natural food preservation system, Antimicrobial agents (Nitrates, Benzoates, Propionates, Sorbates etc.), mechanism of actions of different preservatives, Biological agents, nonionizing and ionizing radiations in the preservation of foods. Hurdle technology.

Reference Books and Suggested Readings:

Title	**Author**
Food Process Engineering & Technology	ZekiBerk
Food Processing and Preservation	B. Sivasankar
Food Processing Technology: Principles and Practice	P.J Fellows
Food Processing Technology: Principles and Practice	M.ShafeiurRahman
Fruits and Vegetable Processing: Improving Quality	WimJongen
Introduction of Food Processing Engineering	P. G. Smith

NFT-206: FOOD CHEMISTRY LAB

L	T	P	C
0	0	4	2

Course objectives: The objectives of this course are

- To train the students with hands on experience with chemical compositions of foods.
- To assist them in analysis of various food constituents, additives present in the food such as nutrients (vitamins), anti nutritional factor (tannins, anthocyanins, flavonoids) etc

Course outcomes: On the successful completion of the course the students will be able to

CO1	Understand the principles behind analytical techniques associated with food	Understanding
CO2	Be able to select the appropriate analytical technique when presented with practical problem	Understanding
CO3	Demonstrate practical proficiency in a food analysis laboratory	Understanding
CO4	Describe and use principal analytical methods used for quantifying the composition and reactions of food components	Applying
CO5	Interpret and report data derived from chemical experiments/analysis in a meaningful way	Analyzing

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	3	1	1	2	1	2	2	2	2	1	1	3	3
CO2	3	1	2	2	1	2	1	1	1	-	1	3	3
CO3	3	2	2	1	1	2	1	2	2	1	1	3	3
CO4	3	2	1	1	1	1	1	1	1	1	1	3	3
CO5	3	2	1	1	1	1	1	1	2	-	1	3	3
Average	**3**	**1.6**	**1.4**	**1.4**	**1**	**1.6**	**1.2**	**1.4**	**1.6**	**1**	**1**	**3**	**3**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put "-"*

Laboratory Experiments

1. Quality analysis of water
2. Determination of moisture content in food by hot air oven method
3. Non-enzymatic browning reactions and its determinations
4. Determination of rate of hydrolysis of sucrose/starch
5. Determination of free fatty acid content and oxidative rancidity in fats and oils
6. Determination of heat stability of vitamin C
7. Determination of functional properties of proteins
8. Determination and identification of additives added to food
9. Determination and identification of adulterants in some foods
10. Determination of salt content in processed products

Reference Books and Suggested Readings:

1. Principles of Food Chemistry, John M, Deman, Chapman and Hall, 3rd Edition, 1999.
2. Food Chemistry, Fennema Owen R., Food Science & Technology series, CRC press, New York, 4th edition, 2007.
3. Food chemistry, Lillian Hoagland Meyer, CBS publication, New Delhi, 2nd Edition, 2006.
4. Food Science Chemistry & Experimental Foods, Dr. M. Swaminathan, Bappco Ltd 2nd Edition, 2001.
5. Food chemistry, S. Yadav, Anmol Publications 1st Edition, 1997

		L	T	P	C
NFT-301	**Technology of Animal and Milk Products**	**3**	**0**	**2**	**4**

Course Objectives: The objectives of this course are to impart-

- Knowledge about milk industry evolution & physicochemical characteristics of milk
- Knowledge of commercial milk and milk products processing technology
- Knowledge about the structure and processing of meat, fish, poultry, and eggs

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand and analyze the scenario of the milk industry, compositional variability of milk, and adulteration in milk	Understanding
CO-2	Understand and explain various types of market milk and their processing technology	Analyzing
CO-3	Understand and evaluate various milk products processing, byproducts, and plant sanitation	Understanding
CO-4	Understand and explain the concepts involved in meat and fish products processing	Analyzing
CO-5	Understand and explain the concept involved in poultry and egg processing	Understanding
CO-6	Evaluate various quality characteristics of milk and milk products, meat, and egg	Analyzing

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	1	-	2	2	1	1	1	1	1	1	2	2	1
CO2	-	1	1	1	1	1	1	1	1	1	1	2	1
CO3	1	1	2	1	1	1	1	1	-	1	1	2	1
CO4	-	-	2	-	-	1	1	1	-	-	2	2	2
CO5	-	-	2	-	-	1	1	1	-	-	2	2	2
CO6	1	1	2	1	2	2	1	-	-	1	1	2	2
Average	1	1	1.8	1.25	1.25	1.16	1	1	1	1	1.5	2	1.5

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- History of the milk revolution and scenario of the milk industry
- Concept of physicochemical characteristics of milk

➢ Production and collection systems of milk
➢ Common adulteration in milk
Course Outcome-2 (CO-2)
➢ Quality tests of received milk
➢ Working principles and parts of Plate heat exchanger
➢ Working principle of homogenizer, clarifier, bactofuge
➢ Sterilization and UHT processing of milk
Course Outcome-3 (CO-3)
➢ Classification, and processing of cream, butter, butter oil, and Ghee
➢ Concept of manufacturing evaporated, condensed, roller, and spray dried milk
➢ Manufacturing technology of frozen milk products
➢ Cleaning and sanitization of dairy equipment
➢ By-products utilization in the dairy industry
Course Outcome-4 (CO-4)
➢ Structure, processing, and by-product utilization of meat
➢ Modern slaughterhouse practices
➢ Structure, processing, and by-product utilization of fish
➢ Value-added products from fish
Course Outcome-5 (CO-5)
➢ Structure, processing, and by-products processing of poultry
➢ Grading and inspection of eggs
➢ Processing methods and value-added products from eggs

SYLLABUS

Module -I: Basic Idea of Milk	**No. of Hours**
White revolution; Present milk industry scenario; Composition of milk; Physico-chemical characteristics; Microbiology of Milk, Collection, cooling, and transportation of milk; Platform tests; Common adulterations in milk; Dairy industry plant layout.	06
Module -II: Processing of Market Milk	
Reception, chilling, clarification, Bactofugation, and storage of milk; Quality tests for milk; Standardization; Homogenization: *Definition, principles, types, and application,* Pasteurization: *Definition, principles, types, and application.* Types of market milk; Packaging, storage, and distribution of pasteurized milk: whole, standardized, toned,	08

double toned and skim milk; Sterilization; UHT Processing.	
Module -III: Milk Products Processing and Plant Sanitation	
Fat Rich dairy products: Cream, Butter, Butter oil, Ghee: Definition, classification, and processing; ***Condensed and dried milk products:*** Evaporated milk, Condensed milk; Spray and drum dried milk solids: Processing, packaging and storage; ***Frozen dairy products:*** Ice-cream, Frozen dessert, Kulfi: Ingredients, processing, storage; ***Fermented dairy products:*** Cheese, Yoghurt, Acidophilus milk, Kefir; ***Indian traditional dairy products:*** Dahi, Channa, Paneer, Khoa etc. ; Dairy plant sanitation: Types of sanitizers, Types of detergents, Cleaning in Place; Byproducts utilization in dairy industry; Whey protein concentrates and isolates.	10
Module -IV: Technology of meat and fish products	
Meat: Status of meat and meat products in India and globally; Chemical composition and structure of meat; Pre-mortem and post-mortem changes influencing the quality of meat; Modern slaughter house practices; Different types of meat cuts; Meat by-product utilization. **Fish:** Chemical composition and structure of fish; Fresh water and marine fish; Harvesting and transportation of fish; Processing and value addition of fish: Pickling, fish protein concentrate, fish oil, and other byproducts.	08
Module -V: Technology of Poultry and Egg	
Poultry: Quality characteristics of poultry products, Poultry meat processing operations and equipment; Poultry meat products; Poultry meat by-products; Plant sanitation. **Egg:** Structure of egg; Structural abnormalities; Functions of egg in the food system; Egg products: liquid whole egg, whole egg powder, egg yolk products; By-products: processing, packaging, and storage, Quality evaluation of eggs.	08
List of experiments	
1. To perform various platform tests for milk	02
2. To estimate various physicochemical properties of milk	02
3. To determine various types of adulterations in milk	02
4. To estimate the pasteurization efficacy of milk	02
5. To study the standardization of milk	02
6. To determine the overrun in the given ice-cream sample	02
7. To prepare flavoured milk	02
8. To prepare a layout of a milk processing plant	02
9. To estimate the water-holding capacity of meat	02
10. To conduct the Candling and Grading of eggs	02
11. Field visit to any dairy/ meat processing industry	

Reference books and suggested readings	
Title	**Author**
Outlines of Dairy Technology. Oxford University Press	De Sukumar
Dairy Technology- Principles of Milk Properties and Processes; Marcel Dekker Inc.	P. Walstra., T.J. Geuits., A. Noomen, A. Jellema and M.A.J.S. Van Boekel
Meat and Meat Products: Technology, Chemistry and Microbiology, Champan & Hill, London, 1995.	H.V. Alan and P.S. Jane
Poultry Meat and Egg Production, CBS Publications, New Delhi	R.O Carmen and J.M. George
Fish and Fish Products, Agrobios, Bikaner	A.L. Winton and K.B. Winton

		L	T	P	C
NFT-303	**Technology of Cereals, Pulses and Oilseeds**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course are to impart-

- Knowledge about the structure and processing of cereals, pulses and oilseeds
- Knowledge about technology of bakery products
- Knowledge on processing of edible oil and its modification

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand the composition, structure and storage of food grains	Understanding
CO-2	Understand the technology of paddy processing and its products	Understanding
CO-3	Understand the traditional and modern milling operations of wheat and technology of bakery and extruded products	Understanding
CO-4	Understand the processing of coarse cereals and legume-pulses and their value added products	Understanding
CO-5	Understand the processing of oil & oilseeds and utilization of their byproducts	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2	1	1	1	-	2	1	-	-	-	1	2	2
CO2	2	1	1	1	-	2	1	-	-	-	1	2	2
CO3	2	1	1	1	-	2	1	-	-	-	1	2	2
CO4	1	1	1	1	-	2	1	-	-	-	1	2	2
CO5	2	1	1	1	-	2	1	-	-	-	1	2	2
Average	1.8	1	1	1	-	2	1	-	-	-	1	2	2

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Production status of cereal grains
- Composition, structure and processing characteristic of cereal grains, legumes and oilseeds
- Post-harvest practices for their safe storage

Course Outcome-2 (CO-2)

- Different methods of parboiling and milling of paddy
- Processing of rice
- Different types of processed rice products

Course Outcome-3 (CO-3)

- Milling of wheat into flour and semolina
- Grading and quality characteristics of flour and semolina
- Baked products
- Breakfast cereals and Macaroni products

Course Outcome-4 (CO-4)	
➢ Milling of corn	
➢ Barley and millet processing	
➢ Processing of legume-pulses	
Course Outcome-5 (CO-5)	
➢ Processing of oil seeds	
➢ Refining and modifications of oils	
➢ Processing of de-oiled cake (DOC)	
➢ Application of DOC into protein products	
➢ Oil based food products	
SYLLABUS	
Modules	**No. of Hours**
Module -I: Composition and Structure	
Production treads, Composition, structure and processing characteristic of cereal grains, Legumes, oil seed processing, Post-harvest and post processing practices for their safe storage.	06
Module -II: Paddy Processing and Processed Products	
Parboiling and milling of paddy, curing and aging of rice, processed rice products.	08
Module -III: Wheat Processing and Processed Products	
Wheat and its quality characteristics for milling into flour and semolina, Flour milling, Turbo grinding and air classification, Flour grades and their suitability for baking purposes, Assessment of flour quality and characteristics, Milling of Durum wheat, Ingredients, production and quality parameters for baked products: Bread, biscuits and cakes; Breakfast cereals, Macaroni products.	10
Module -IV: Coarse Cereals and Legume-Pulses Processing	
Dry and Wet milling of corn, Starches and its conversion products, Malting of barley, Pearling of millets, Milling of legume-pulses by traditional and improved processes.	08
Module -V: Oilseeds Processing and Processed Products	
Processing of oil seeds for direct use and consumption, Oil and protein products, Refining: Physical and Biorefinining, Hydrogenation and Interestrification of oil, Processing of de-oiled cake into protein concentrates and isolates, Textured protein, Functional protein preparations, Peanut butter, Margarine and Spread.	08

Reference books and suggested readings

Title	**Author**
Manuals on Rice and its Processing	CFTRI, Mysore
Food Science	N. N. Potter
Cereal Technology	SA Matz
Bakery Technology	SA Matz
Cereals and Cereal Processing: Chemistry and Technology	DAV Dendy and B.J. Dobrazczyk
Cereal Technology	Kent

		L	T	P	C
NFT-305	**Fruits, Vegetables and Plantation Products**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart-

- Skill and Knowledge required to apply the concepts of post-harvest handling, supply chain management, preservation techniques, and value addition of fresh fruits and vegetables for extending the shelf life.
- Knowledge about the processing of spices and other plantation products besides the application of emerging technologies for shelf life extension and value addition of fresh produce.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand and analyze the post-harvest changes and handling of fresh fruits and vegetables	Analyzing
CO-2	Understand and apply various conventional preservation techniques for shelf life extension of fruits and vegetables	Applying
CO-3	Understand and apply the concepts of processing various fruits and vegetable based value added products	Applying
CO-4	Understand the processing of spices and other plantation products	Understanding
CO-5	Understand the application of emerging technologies for the shelf life extension and processing of fruits and vegetables	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	1	-	2	-	-	1	1	1	-	1	2	2	2
CO2	-	1	2	1	1	2	1	1	-	1	2	2	2
CO3	-	-	1	-	1	2	1	1	-	1	1	2	2
CO4	-	-	1	-	1	1	1	-	-	-	1	2	2
CO5	1	1	2	1	2	2	1	-	1	2	2	2	2
Average	1	1	1.6	1	1.25	1.6	1	1	1	1.25	1.6	2	2

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Review on the status of production and processing of fruits and vegetables
- Chemical composition and nutritive value of fruits and vegetables

➢ Post-harvest changes in fresh produce	
➢ Physicochemical treatments to improve the shelf life of fruits and vegetables	
➢ Supply chain management of fresh fruits and vegetables	
Course Outcome-2 (CO-2)	
➢ Methods of chilling and freezing fruits and vegetable	
➢ Changes during chilling and freezing fruits and vegetable	
➢ Canning and aseptic processing of fruits and vegetables	
➢ Different drying techniques for fruits and vegetables	
Course Outcome-3 (CO-3)	
➢ Processing of fruit juices and beverages	
➢ Processing of pectin based jel like products	
➢ Processing of tomato products	
➢ Processing of sugar-impregnated fruits and vegetable products	
➢ Processing of fermented fruits and vegetable-based products	
Course Outcome-4 (CO-4)	
➢ Processing of major and minor spices	
➢ Processing of Plantation products	
➢ Processing of Cocoa and Cocoa products	
➢ Processing of major nuts	
Course Outcome-5 (CO-5)	
➢ Emerging technologies for processing fruits and vegetable	
➢ Minimal processing of fruits and vegetables	
➢ Concept of Hurdle Technology	
SYLLABUS	
Module-1: Post-Harvest Handling of Fruits & Vegetables	**No. of Hours**
Current status of production and processing of fruits and vegetables; Chemical composition and nutritional value of fruits and vegetables; Pre and post-harvest changes; Maturity indices for harvesting and storage; Desirable characteristics of fruits and vegetables for processing; Post-harvest management of fruits and vegetables; Transportation and storage of fresh produce; Supply chain management for fresh produce.	08
Module – II: Preservation of Fruits & Vegetables	
Low-temperature preservation: Chilling/ refrigeration, Freezing, Cryogenic freezing,	06

Frozen storage, Thawing, Defects during low-temperature storage. ***Thermal processing:*** Canning and bottling, Spoilage of canned foods, Aseptic processing. ***Drying and dehydration:*** Types of dryers, Changes during drying, Quality of dried products	
Module – III: Processing Technology of Fruits & vegetables based Products	
Juices; Pulps; Squashes; Cordials, and other beverages; Concentrates; Powders; Jams, Jellies, Marmalades; Preserves, Candies, and Crystallized fruits; Chutneys; Pickles; Vinegar; Fruit wine; and other products. ***Tomato processing:*** Puree, Paste, Ketchup, Sauce, and soup.	10
Module – IV: Processing Technology of Spices & Plantation Products.	
Spices: Composition, Structure, and characteristics; Preservation and processing of major and minor spices of India; Whole spice, Spice powder, Paste and extracts, Spice oils, and Oleoresins. **Tea:** Composition, production, and processing of Tea leaves: Black tea, Green tea, Oolong tea, Instant tea. **Coffee:** Production and processing of coffee cherries: wet and dry methods, grinding, storage, and preparation of brew; Soluble/Instant coffee; Use of chicory in coffee; decaffeinated coffee. **Nuts:** Composition, structure, and processing of cashew nuts, Sprouted cashew, cashew milk and other dry fruits. **Cocoa:** Production, Chemical composition, and Processing of cocoa beans. ***Manufacturing of chocolate:*** Ingredients, Processing, and Defects.	10
Module – V: Emerging Technologies for fruits and vegetable processing	
Irradiation application; Ozone application; High-Pressure Processing; Pulsed Electric Field processing; Ultrasound treatment, and other novel fruit and vegetable processing techniques. Minimal processing; Hurdle Technology.	06

Reference books and suggested readings

Title	**Author**
Advances in Postharvest Fruit and Vegetable Technology	Ron B.H. Wills., John Golding
Preservation of fruits and vegetables	Girdharilal, Siddappaa, G.S.
Handbook of analysis and quality control for fruits and vegetable products	Ranganna S.
Foods: Facts and Principles, New Age Publishers.	Manay, S. & Shadaksharaswam
Food Science	Potter, Norman
Harvest Technology of Fruits and Vegetables	Verma, L.R and Joshi, V.K.

		L	T	P	C
NFT-307	**Food Processing Laboratory**	**0**	**0**	**6**	**3**

Course Objectives: The objective of this Laboratory is to

- Enable students to understand the food preservation and processing operations and their practical applications in food processing Industries.

Course Outcomes: On the successful completion of the course, students will be able to

CO1	Understand processing and preservation of Fruits and Vegetables and their value added products.	Understanding
CO2	Understand processing of Cereals, Pulses And Oilseeds.	Understanding
CO3	Assess the quality of finished food products, including sensory evaluation, chemical composition, and shelf-life assessment.	Evaluating
CO4	Apply food labelling requirements and regulations to ensure compliance with industry standards.	Applying

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2	2	3	2	1	3	2	3	3	2	2	3	1
CO2	2	2	3	2	1	3	2	3	3	2	2	3	1
CO3	2	2	3	2	3	1	2	3	3	2	3	1	1
CO4	1	1	1	1	-	1	2	3	3	2	3	1	1
Average	1.7	1.75	2.5	1.75	1.6	2	2	3	3	2	2.5	2	1

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Sr. No.	**Name of Practical**	**Contact Hrs.**
1	Processing and preservation of non-alcoholic fruit beverages (RTS, cordial, and squash) using permitted chemical preservatives.	6
2	Processing and Preservation of Jam, Jelly and Marmalade.	6
3	Processing and Preservation of Tomato Sauce.	6
4	Processing and Preservation of Fruits/Vegetables by Canning Method.	6

5	Osmotic dehydration of fruits/vegetables by sugar and salt solution.	6
6	Processing of Dehydrated Onion Powder/Flakes.	6
7	Milling of Pulses and Effect of Pretreatments on Dal Recovery and milling Efficiency.	6
8	Preparation of Bread, Biscuit and Cake.	6
9	Preparation of Soy Milk and Tofu (Soy Paneer).	6
10	Processing and quality assessment of oil seeds.	6
11	Production & Processing of Potato Chips.	6
12	Determination of Average Size of Cereal/pulses Flour by Sieve Analysis.	6

Reference books and suggested readings

Title	**Author**
Laboratory Manual	-
Preservation of fruits and vegetables	Girdharilal, Siddappaa, G.S.
Handbook of analysis and quality control for fruits and vegetable products	Ranganna S
FSSAI Manual of Methods of Analysis of Foods – Cereal and Cereal Products -2nd edition.	FSSAI
FSSAI Manual of Methods of Analysis of Foods – Oil and Fats	FSSAI
FSSAI Manual of Methods of Analysis of Foods-Fruit and Vegetable products	FSSAI
Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011	-
Food Safety and Standards (Labelling and Display) Regulations, 2020	-

		L	T	P	C
NFT-302	**Food Safety and Quality Control**	**3**	**0**	**2**	**4**

Course Objectives: The objectives of this course are to impart-

- Fundamental knowledge of quality control and total quality management systems in the food industry.
- Knowledge about food hygiene and the importance of safe food
- Knowledge about the regulatory framework for ensuring food quality and safety
- Knowledge of Food safety management system

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand concepts of Food Quality and the role of a Total Quality Management system in the food industry	Understanding
CO-2	Understand the concepts of food safety and risk management	Understanding
CO-3	Understand the concept and application of knowledge about food safety management systems in the food industry	Analyzing
CO-4	Understand the national and international food laws and regulations	Understanding
CO-5	Understand various international certifications for the food industry	Applying
CO-6	Evaluate the quality characteristics of various food products	Applying

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	-	1	-	-	2	1	1	-	1	1	1	1
CO-2	-	1	2	-	1	2	1	1	-	2	1	1	1
CO-3	1	1	2	-	1	2	2	1	1	2	1	1	2
CO-4	-	-	1	-	-	2	2	1	-	2	1	2	2
CO-5	-	-	1	-	1	2	2	1	-	2	1	2	2
CO-6	1	1	2	1	2	2	1	-	-	1	1	2	2
Average	1	1	1.5	1	1.25	2	1.5	1	1	1.6	1	1.5	1.6

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Fundamentals of Food Quality
- Aspects of Food Quality Control and Quality Assurance
- Sensory evaluation of food products

➢ Concepts of TQM	
➢ Determining the quality attributes of food products	
Course Outcome-2 (CO-2)	
➢ Principles of Food Safety	
➢ Various food hazards	
➢ Risk management protocols	
➢ Concepts of Food Adulteration	
Course Outcome-3 (CO-3)	
➢ Implementation of HACCP systems	
➢ Food Safety Management System and its significance	
➢ Various Prerequisite programs (PRPs)	
➢ Importance of Food safety audit	
Course Outcome-4 (CO-4)	
➢ Provisions of Food Safety and Standards Act (2006)	
➢ Functions of Food Safety and Standards Authority of India (FSSAI)	
➢ Role of Codex Alimentarius Commission in international trade	
➢ harmonization of food standards	
Course Outcome-5 (CO-5)	
➢ Various ISO certifications for the food industry	
➢ Provisions of BRC and other certification	
➢ Provisions for Kosher and Halal types community specific certifications	
➢ Provisions of the Global Food Safety Initiative	
Course Outcome-6 (CO-6)	
➢ Testing and evaluation of various parameters of food quality	
➢ Assessment of quality of foods from different food categories	
➢ Different techniques to perform sensory evaluation study of foods	
SYLLABUS	
Module-1: Concepts of Food Quality	**No. of Hours**
Concept of Food Quality: Definitions, importance, and factors influencing food quality; Quality attributes of food; Sensory evaluation of quality characteristics; Quality attributes of various food commodities- water, dairy, fruits, and vegetables, etc.; Instrumental measurement of food quality: Techniques for analyzing physical and chemical properties (pH, moisture content, color, texture etc.); Quality Control vs. Quality Assurance:	10

Definitions, roles, and differences between QC and QA.; Statistical quality control: Techniques for monitoring and controlling variability in food production processes; Quality Cost; Total Quality Control (TQC); Total Quality Management (TQM).	
Module-2: Food Safety Fundamentals	
Introduction to Food Safety: Definitions, importance, and historical perspectives; Food Hazards: Physical, chemical, and microbiological hazards; Food Allergens; Foodborne infection and intoxication; Food adulteration; Food Fraud; Food Additives; Risk Analysis, Risk Management, Risk Assessment, Risk Communication; Traceability and authentication, Food Recall, Blockchain Technology.	08
Module-3: Food Safety Management Systems	
Introduction; Components of food safety management system; Hazard Analysis Critical Control Point (HACCP); Prerequisite programs (PRPs): Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Agricultural Practices (GAP); Food Safety Audits: Internal audit, Third-party audit.	08
Module-4: Regulatory Framework for Food Safety	
Food Safety and Standards Act, 2006: Provisions, various regulations; Food Safety and Standards Authority of India (FSSAI): Composition, Functions and responsibilities; Preparation and Enforcement of food regulations in India; Codex Alimentarius Commission (CAC); Sanitary and phytosanitary Measures (SPS); Introduction to major international food safety regulatory bodies: USFDA, CFIA, FSANZ, EFSA, FSIS; Voluntary standards: BIS and AgMark; Harmonization of food standards.	08
Module-5 International Food Quality and Safety Certification	
ISO 9000; ISO 22000; FSSC 22000 (Food Safety System Certification); BRC Global Standard for Food Safety; GFSI (Global Food Safety Initiative) Certification; Kosher Certification; Halal Certification; other similar certifications	06
List of experiments	
1. To conduct sensory analysis of food samples	02
2. To detect the adulteration in food samples	02
3. Texture profile analysis of food samples	02
4. To evaluate the quality characteristics of Bakery Products	02
5. To evaluate the quality characteristics of Dairy Products	02

6. To assess the quality characteristics of wheat flour	02
7. To evaluate the quality characteristics of fruit-based beverages	02
8. To evaluate the quality characteristics of Jam, Jelly, Marmalades	02
9. To evaluate the labels of packaged food samples in light of regulations	02
10. To evaluate the microbial quality of food product	02
11. To visit any food testing laboratory/ organization	

Reference books and suggested readings

Title	**Author**
Food Quality Assurance: Principles and Practices	Inteaz Alli
Rheology and Texture in Food Quality	J.M. DeMan
Food Analysis: Theory and practice	Y. Pomeranz
Principles of Sensory Analysis of Food	M.A. Amerine
FSSA Act and regulations	

		L	T	P	C
NFT-304	**FERMENTED FOODS & BEVERAGE TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives: The objective of this course is to impart

- Knowledge about types of fermentation and principles & procedures involved in the production of fermented food products.
- Characteristics and production methods of both alcoholic and non-alcoholic beverages, basic concepts of their quality parameters.

Course Outcomes: On the successful completion of the course, students will be able to

CO1	Understand the types of fermentation and the importance of fermented food products.	Understanding
CO2	Understand the principles and apply the processing techniques for plant- based fermented food products.	Understanding , Applying
CO3	Understand the principles and processing techniques of fermented milk, meat, and fish products, and apply methods to assess their quality.	Understanding , Applying
CO4	Understand the manufacturing processes and quality evaluation of alcoholic beverages, including the role of yeast, brewing technologies, and different types of alcoholic beverages. .	Understanding
CO5	Understand the manufacturing processes, quality evaluation, and regulatory standards for packaged drinking water, carbonated beverages, and specialty beverages. .	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO2	1	2	-	-	-	3	2	2	-	1	2	2	1
CO3	1	2	-	-	-	3	2	2	-	1	2	2	1
CO4	1	2	2	-	-	3	2	2	-	1	2	2	1
CO5	1	1	2	-	-	3	2	2	-	1	2	2	1
Average	1	2	2	-	-	3	2	2	-	1	1.8	1.8	1

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)* *If there is no correlation, put "-"*

Course Level Assessment Questions

Course Outcome 1 (CO1)

- Definition and types of fermentation.

➢ Health benefits of fermented foods.	
➢ Understanding pathways of lactic acid, alcoholic, and acetic acid fermentation.	
➢ Preparation and maintenance of bacterial, yeast, and mold cultures.	
Course Outcome 2 (CO2)	
➢ Production technology of plant-based fermented food products.	
➢ Microorganisms involved and optimum conditions in plant-based fermented food products.	
➢ Basic concept of spoilage and defects in plant-based fermented foods and their control.	
Course Outcome 3 (CO3)	
➢ Production technology of fermented milk, meat, and fish products.	
➢ Microorganisms involved and optimum conditions in animal-based fermented food products.	
➢ Basic concept of spoilage and defects in animal-based fermented foods and their control.	
Course Outcome 4 (CO4)	
➢ Technological concept of beer and wine production	
➢ Role of yeast in beer and other alcoholic beverages.	
➢ Brewing process and equipment used for brewing and distillation	
➢ Quality evaluation of different types of alcoholic beverages.	
Course Outcome 5 (CO5)	
➢ Manufacturing process of packaged drinking water.	
➢ Quality evaluation and regulatory standards for bottled water	
➢ Manufacturing process of carbonated and specialty beverages.	
➢ Role of various ingredients in soft drinks and the carbonation process.	
SYLLABUS	
Module-1: Fermentation types and their pathways	**No. of Hours**
Fermentation: Definition, Types of fermentation: Lactic acid fermentations, Alcoholic fermentations, Acetic acid fermentations. Application of Fermentation in Food Industries, Advantages & Health Benefits of Fermented Foods, Preparation and Maintenance of bacterial, yeast and mold cultures for food fermentations.	7
Module – II: Fermentation of Plant based Products & Mushrooms cultivation	
Production technology, microorganisms involved, Spoilages & defects, their control of plant based fermented food products: idli, dosa, dhokla, sauerkraut, kimchi, pickles, Natto, Tempeh, Koji & Miso, Kombucha. Fermentation of Vinegar, Mushrooms: types, nutritional importance, cultivation and preservation.	7
Module – III: Fermentation of Animal based Products	

Production technology, microorganisms involved , Spoilages & defects, their control of Animal based fermented food products: Dahi, Yoghurt, Butter milk, Kefir, Kumis, Cheese Fermented fish products, Fermented meat products	7
Module – IV: Alcoholic Beverages	
Alcoholic beverages- types, manufacturing and quality evaluation, role of yeast in beer and other alcoholic beverages, ale & lager type beer, Malting : technology of brewing process, equipment used for brewing and distillation, wine and related beverages, cider, distilled spirits.	**7**
Module – V: Packaged drinking water, carbonated beverages, and other specialty beverages	
Packaged drinking water- definition, types, manufacturing, processes, quality evaluation, methods of water treatment, BIS Specifications, quality standards of bottled water, mineral water, natural spring water, flavored water, carbonated water, technology of still, carbonated, low-calorie and dry beverages, isotonic and sports drinks, role of various ingredients of soft drinks, carbonation of soft drinks.	7

Reference books and suggested readings

Title	**Author**
Microbiology and Technology of Fermented Foods	Hutkins, R. (2006), IFT Press, Blackwell Publishing
Handbook of Food and Beverage Fermentation Technology.	Hui, Y.H.
Food Fermentation and Micro-organisms	Bamforth, C. W. and Cook, D. J. (2019)
Microbiology of fermented foods	
Microbiology and biochemistry of cheese and fermented milk.	Edited by B.A. Law New York, Blackie Academic & professional.
BIS specification IS 10500:2012	-
Beverages: Technology, Chemistry and Microbial	Varnam and Sutherland

		L	T	P	C
NFT-306	**FOOD PACKAGING AND STORAGE ENGINEERING**	**3**	**0**	**0**	**3**

Course Objectives: The objective of this course is to impart

- Knowledge of packaging, package developments and packaging laws and regulations in food industries.
- Knowledge of different types of packaging materials and their forms used in food packaging.
- Knowledge about package performance and various testing of packaging materials.
- Knowledge about storage of food and food products.

Course Outcomes: On the successful completion of the course, students will be able to

CO1	Understand basic concept of packaging, printing and packaging laws & regulations in food industries.	Understanding
CO2	Understand different types of packaging material & their properties and apply the knowledge in packaging of various food commodities	Understanding Applying
CO3	Understand the selection of packages for specific food & agricultural commodities.	Understanding
CO4	Analyze the performance and quality of packaging materials	Analyzing
CO5	Understand the designing of storage structures for food commodities	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	2	2	2	-	2	1	-	-	-	2	2	-
CO2	3	2	3	2	-	3	1	-	-	-	2	2	2
CO3	1	2	3	1	-	3	1	-	2	-	1	2	2
CO4	2	2	2	1	-	2	1	-	-	-	2	2	2
CO5	3	2	3	2	-	1	1	-	2	-	1	2	1
Average	**2.4**	**2.6**	**2.6**	**1.6**	**-**	**2.2**	**1**	**-**	**2**	**-**	**1.6**	**2**	**1.75**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome 1 (CO1)

- Challenges & opportunities in Food packaging industry
- Printing and packaging laws& regulations
- Significance of packaging in Food industry

Course Outcome 2 (CO2)	
➢ Packaging Materials	
➢ Types of packaging materials in food industry	
➢ Selection criteria for packaging of food products	
Course Outcome 3 (CO3)	
➢ Packages for specific food & agricultural commodities	
➢ Advancement in food packaging	
Course Outcome 4 (CO4)	
➢ Testing of packaging materials	
➢ Shelf life analysis of packaged foods	
Course Outcome 5 (CO5)	
➢ Spoilage of grains, fruits & vegetables and their prevention	
➢ Design parameter for different storage bins	
➢ Designing of cold storage and other types of storage structures	
SYLLABUS	
Module-1: Introduction of Packaging	**No. of Hours**
Concept of packaging, Important functions of package, Packaging laws and regulations: Printing techniques; Package labeling: functions and regulations; Environmental aspect of food packaging	**06**
Module – II:	**08**
Glass containers and closures, Metal containers: tin-plate containers, tin free steel containers, aluminum and other metal containers. Protective lacquers and coatings for metal containers. Wooden crates, plywoods, cellulosic papers, pouches, bags and card board / corrugated paper boxes. Rigid and flexible packaging: laminates, containers and films and their mechanical sealing and barrier properties.	
Module – III:	**08**
Selection of Packaging materials, forms and machinery for various food commodities: Fruits and vegetable and their products, Milk and milk products, Meat, fish, egg etc., cereals, pulses and oilseeds products, confectionery etc. Evaluation of quality, safety and interaction with foods of various types of packaging materials. Gas, vacuum, CAP, MAP and aseptic packaging, Tetra packing, Smart packaging, Intelligent Packaging, Active Packaging and Antimicrobial packaging, Retortable pouches, biodegradable and edibles packaging materials and films.	

Module – IV:	**08**
Destructive & Nondestructive test of rigid, semi rigid and flexible packaging material: tensile strength, compression, bursting, tear and impact test for packages, integrity testing. Cushioning effect on packaged foods, deterioration of packaged foods, shelf life study for packaged foods. Corrosion and toxicity of packaging material.	
Module – V:	**08**
Design parameter for different storage bins for different grains, Milk silo, Design parameter, selection of parameter for designing cold storage for foods different storage. Spoilage of fruits & vegetables during transportation & storage and its prevention. Factors affecting quality of grain during storage. Causes and prevention of spoilage of grain during storage	

Reference books and suggested readings

Title	**Author**
Food Packaging: Principles and Practice	Robertson G.L.
Food Packaging Materials	Mahadeviah M. and Gowramma R.V
Principles of Food Packaging	Saclarow S. and Griffin R.C.,
Food and Package Engineering	Scott A. Morris
Food Packaging and Preservation	Alexandru Grumezescu Alina Maria Holban

		L	T	P	C
NFT-308	**Advanced Food Instrumentation Lab**	**0**	**0**	**6**	**3**

Course Objectives: The objectives of this course are to impart-

- The knowledge about the analysis of food quality characteristics using advanced testing instruments
- The knowledge to correlate the instrumental analysis with the sensory analysis of foods

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand the instrumental analysis of the physicochemical properties of foods	Understanding and Analyzing
CO-2	Understand the instrumental analysis of the thermal properties of foods	Understanding and Analyzing
CO-3	Understand the instrumental analysis of the functional properties of foods	Understanding and Analyzing

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	-	1	-	-	2	-	1	-	-	1	2	1
CO-2	-	3	1	1	1	2	-	1	-	-	1	2	1
CO-3	1	2	1	-	1	2	-	1	-	-	1	2	1
Average	1	1.6	1	1	1	2	0	1	-	-	1	2	1

List of experiments

1. To study the textural characteristics of food using Texture Analyzer	**No. of Hours**
2. To analyze the antioxidants present in food using a Spectrophotometer	06
3. To study the thermal characteristics of food using a Differential Scanning Colorimeter (DSC)	06
4. To study the properties of starch using Rapid Visco Analyzer (RVA)	06
5. To study the heavy metals in food using Atomic Absorption Spectrometer	06
6. To determine the colour values of different food products	06
7. To study the effect of Ultrasonication on the extraction of bioactive components of foods	06
8. To study the functional groups of food samples using Fourier Transform Infrared (FTIR) Spectroscopy	06
9. To study the fatty acid profile of an oil sample using Gas Chromatography	06
10. To study the particle size of the food powder using a Particle Size Analyzer	06
11. To visit an analytical food testing laboratory/ organization	

Reference books and suggested readings	
Title	**Author/ editor**
Laboratory Manual	
Applications of Instrumental Methods for Food and Food By-Products Analysis. MDPI.	Agata Górska
Food Analysis Laboratory Manual, Springer	

		L	T	P	C
OFT-302	**Basic concept of Food Processing and Preservation**	**2**	**0**	**0**	**2**

Course Objectives: The objective of this course is to impart

- Knowledge of degree of perishability and causes of quality deterioration and spoilage of perishable foods
- Knowledge in processing and preservation methods to control food spoilage and deterioration.
- Knowledge of food quality and safety of food.

Course Outcomes: On the successful completion of the course, students will be able to

CO1	Understand the type of food based on perishability and causes of food spoilage	Understanding
CO2	Understand the principle of low temperature preservation	Understanding
CO3	Understand the principle of thermal processing and applying high temperature processing in food industry	Understanding, Applying
CO4	Understand the principles of non-thermal preservation methods	Understanding
CO5	Understand concepts of Food quality and safety	Understanding

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	3	1	-	1	-	1	-	-	-	-	1	2	1
CO2	3	2	-	1	-	1	-	-	-	-	1	2	1
CO3	3	2	-	1	-	1	-	-	-	-	1	2	1
CO4	3	2	-	1	-	1	-	-	-	-	1	2	1
CO5	3	2	1	-	-		-	-	-	-	1	2	1
Average	**3**	**1.8**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**2**	**1**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome 1 (CO1)

- Aims and objectives of food preservation
- Composition and types of food based on perishability
- Causes of food spoilage: microbial, physical, chemical, and other factors

Course Outcome 2 (CO2)

- Principles of low temperature preservation

➢ Methods and effects of refrigeration and freezing on food quality	
➢ Controlled and modified atmosphere storage	
Course Outcome 3 (CO3)	
➢ Principles of heat preservation and thermal resistance of microorganisms	
➢ Impact of thermal treatments (boiling, pasteurization, UHT, sterilization, canning, blanching) on food quality	
Course Outcome 4 (CO4)	
➢ Principles and working mechanisms of non-thermal preservation methods	
➢ Mechanisms of action of chemical preservatives	
➢ Introduction to advanced preservation techniques (high pressure processing, ohmic heating, pulse electric field processing, irradiation)	
➢ Concept of hurdle technology	
Course Outcome 5 (CO5)	
➢ Concepts of food quality: definitions, importance, and influencing factors	
➢ Introduction to food safety: definitions, importance, historical perspective	
➢ Identification and management of food hazards (physical, chemical, microbiological)	
➢ Food adulteration and its prevention	
SYLLABUS	
Module-1: Composition of Food and causes of food spoilage	**No. of Hours**
Introduction and Historical Development of Food Preservation ,Composition of Food, Type of Food based on perishability, General Principles of Food Preservation, Basic concepts in microbial growth, Cause of Food Spoilage.	**05**
Module – II: Preservation of foods by low temperature	**06**
Preservation by low temperature - Low temperature storage, refrigeration and freezing , slow and fast freezing, Controlled and modified atmosphere storage of foods, Preservation by drying; Phenomenon and methods of drying-dehydration by air drying, sun drying and freeze drying. Intermediate moisture foods.	
Module – III: Preservation of Foods by high temperature	**05**
Preservation by heat; Principles of heat preservation, heat resistance of micro-organisms and their spores. Thermal death time. Heat treatments- boiling, pasteurization, UHT, sterilization, canning, blanching.	
Module – IV: Non- Thermal Method of Processing and Preservation of Foods	**05**
Definition of chemical preservatives and types. Introduction to new techniques in preservation of food like high pressure processing, pulse electric field processing,	

irradiation and hurdle technology etc.	
Module – V: Introduction to Food Quality and Safety	**04**
Food quality: Definitions, importance and factors influencing food quality, Quality attributes of food. Introduction to Food safety : definitions, importance and historical perspective, Food Hazards; Physical, chemical and microbiological hazards, Food adulteration	

Reference books and suggested readings

Title	**Author**
Physical Method of Food Preservation	O.R. Fennema
Food Processing and Preservation	B. Sivasankar
Food Processing Technology : Principles and Practice	P.J Fellows
Food Quality Assurance	I. Ali
Physical Method of Food Preservation	O.R. Fennema

		L	T	P	C
NFT – 401	**NUTRACEUTICAL AND FUNCTIONAL FOODS**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course is to impart

- Fundamental knowledge of Nutraceuticals and Functional Foods
- Knowledge about Phytochemicals and Nutrient Bioavailability
- Knowledge about Nutraceuticals in Modern Nutrition
- Knowledge about Advanced Bioactive Extraction Methods
- Knowledge about Guidelines and Legal Aspects of using Nutraceuticals

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the concepts of nutraceuticals and functional foods and their classification	Remember & Understand
CO-2	Discuss the bioavailability and bio accessibility of bioactive compounds	Understand
CO-3	Discuss various Nutraceutical foods based on their sources and functions in Modern Nutrition	Understand
CO-4	Demonstrate various advanced methods for nutraceuticals extraction	Apply
CO-5	Discuss and implement the Guidelines & Regulations for development of Nutraceuticals & Functional Food	Understand & Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	-	1	-	-	-	1	-	1	-	2	2	2
CO-2	1	-	1	-	1	2	1	-	1	-	2	3	3
CO-3	1	-	1	-	1	2	1	-	1	-	2	2	2
CO-4	1	-	1	-	1	2	2	1	1	-	2	3	2
CO-5	1	-	1	-	-	2	3	1	1	-	2	2	2
Average	**1**	**-**	**1**	**-**	**1**	**2**	**1.6**	**1**	**1**	**-**	**2**	**2.4**	**2.2**

1: Slight (Low) *2: Moderate (Medium)* *3: Substantial (High)*

If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Introduction to functional food and nutraceuticals
- Classifications of nutraceuticals and functional foods
- Market demand for nutraceuticals and functional food

Course Outcome-2 (CO-2)

- Bioavailability and Bio accessibility of functional foods
- Purification and concentration of bioactive compounds
- Introduction to Prebiotics, probiotics, synbiotics and postbiotics

Course Outcome-3 (CO-3)

- Properties, Structure and Functions of Various Nutraceuticals
- Herbs and Spices: Classification as functional foods
- Nutraceuticals Rich Supplements

Course Outcome-4 (CO-4)	
➢ Traditional extraction methods of functional food and nutraceuticals	
➢ Modern extraction methods of functional food and nutraceuticals	
➢ Microencapsulation techniques	
Course Outcome-5 (CO-5)	
➢ Regulatory aspects and health claims of nutraceuticals	
➢ Marketing and regulatory issues of Nutraceuticals and functional foods	
➢ CODEX, EU and FSSAI guidelines for use of Nutraceuticals and functional foods	
SYLLABUS	
MODULES	**No. of Hours**
Module-1: Introduction to Functional Foods and Nutraceuticals	6
Introduction to functional food and nutraceuticals, definition, history and classification based on chemical and biochemical nature. Food as Remedies: Nutraceuticals Bridging the Gap between Food and Drug, Market demand for nutraceuticals and functional foods. Scope and Future prospects of Nutraceuticals & Functional Foods.	
Module-2: Phytochemicals and Nutrient Bioavailability	10
Bioavailability and Bioaccessibility of Polyphenols and Flavonoids, Alkaloids, Glucosinolates, Terpenoides, Catechins, Phytochemicals, Isoflavones, Anthocyanins. Pigments: Carotenoids, Lycopene, Curcumin and other plant pigments. Purification and concentration of bioactive compounds. Role of biotechnology in the extraction of functional food components. Introduction to Prebiotics, Probiotics, Synbiotics and Postbiotics.	
Module-3: Nutraceuticals in Modern Nutrition	14
Properties, Structure and Functions of Various Nutraceuticals - Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine Alpha Keto-glutarate. Use of Pro-anthocyanidins, Grape Products, Flaxseed Oil as Nutraceuticals. Role of Nutraceuticals in Maternal Nutrition, Medical Foods and Infant Formulas, Functional Beverages and Designer foods. Herbs and Spices: Classification as functional foods. Health promoting activity of common herbs based on functional effects. Problems in using herbs as food ingredient. Nutraceuticals Rich Supplements - Bee Pollen, Caffeine, Green Tea, Grape Tea, Wheat Grass, Lecithin, Mushroom Extract, Chlorophyll, Kelp and Spirulina, Garcinia Cambogia , Aloe Vera and Blue Tea.	
Module-4: Advanced Bioactive Extraction Methods	10
Extraction methods: Soxhlet extraction, maceration, hydro-distillation methods, Modern extraction methods: Supercritical fluid extraction, pressurized liquid extraction, ultrasound assisted extraction and microwave assisted extraction. Microencapsulation: spray-drying, freeze-drying, coacervation phase separation technique.	

Module-5: Regulations and Claims in Nutraceuticals & Functional Food	8
FOSHU foods – concepts, regulatory aspects. Food component – approved health claims, labeling considerations for functional ingredients; case studies. Permissible and impermissible functional claims, Marketing and regulatory issues for functional foods and nutraceuticals: CODEX Guidelines, EU guidelines and FSSAI guidelines.	

Reference books and suggested readings

Title	**Author**
Handbook of Nutraceuticals and Functional Foods (CRC Press)	Wildman RE, 2001
Functional Foods: Principles and Technology	Gordon MH, 2015
Functional Foods and Nutraceuticals: Technology and Food Safety	Raghavarao & Sharma, 2017
Herbs and Spices: Bioactive Constituents, Effects and Applications	Friaz et al., 2017
Modern Extraction Techniques: Food, Pharmaceutical and Natural Products	Ahuja & Dong, 2007
Regulation of Functional Foods and Nutraceuticals: A Global Perspective (Elsevier)	Hasler CM & Bagchi D, 2005

		L	T	P	C
NFT – 402	**INNOVATIVE TECHNIQUES IN FOOD PROCESSING**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course is to impart

- Knowledge about working principles and process of various innovative techniques in food processing
- Knowledge about application of innovative techniques for food processing and preservation

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Report the overview of current trends in Food Processing industries	Understand
CO-2	Explain and demonstrate the separation and extraction techniques in food processing	Understand & Apply
CO-3	Discuss and interpret the working principles of Thermal and Non Thermal Techniques in food processing	Understand & Apply
CO-4	Describe and execute green extraction techniques in food processing	Understand & Apply
CO-5	Describe and demonstrate Novel Techniques in Food Processing	Understand & Apply

CO-PO Mapping

COs	**Pos**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	2	1	-	-	-	-	-	-	1	-	1	3	3
CO-2	2	1	-	-	-	2	-	-	1	-	1	3	3
CO-3	2	1	1	-	1	2	-	-	1	-	1	3	3
CO-4	2	1	1	-	1	3	-	-	1	-	1	3	3
CO-5	2	1	1	-	1	3	-	-	1	-	1	3	3
Average	**2**	**1**	**1**	**-**	**1**	**2.5**	**-**	**-**	**1**	**-**	**1**	**3**	**3**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Overview of Traditional vs. Modern Food Processing
- Concept of Minimal Processing in food
- Trends in the Global Food Industry

Course Outcome-2 (CO-2)

- Application of Traditional separation technologies
- Principle and technology of membrane processing
- Application of Traditional extraction technologies in food preservation

Course Outcome-3 (CO-3)

- Principle and Technological aspect of various Thermal Preservation Techniques
- Principle and Technological aspect of various Non-Thermal Preservation Techniques

Course Outcome-4 (CO-4)

- Principle, Technology and application of SCF in food processing and preservation
- Principle and Technology of UAE, MAE in food technology
- Principle and Technology of EAE and sub critical water extraction technology

Course Outcome-5 (CO-5)	
➢ Principle and application of Advanced Extrusion Techniques in food	
➢ Application of Cryogenic-processing of foods	
➢ Use of Atmospheric Pressure Plasma Technology and PAT in food processing	
SYLLABUS	
MODULES	**No. of Hours**
Module-1: Introduction to Innovation in Food Processing	6
Overview of Traditional vs. Modern Food Processing, Consumer demand, sustainability, shelf-life, nutrition. Concept of Minimal Processing, Trends in the Global Food Industry, Plant-based meat, Personalized Nutrition, Digital Traceability.	
Module-2: Separation & Extraction Techniques	10
Filtration, centrifugation, sedimentation, leaching: Definition, principle and process. Introduction to pressure activated membrane processes: microfiltration, Ultra filtration, Nano filtration and Reverse Osmosis and their industrial application. Traditional extraction technology: Solvent extraction, Steam distillation, Cold pressing, Maceration, Infusion, Percolation and Hydro distillation.	
Module-3: Thermal and Non-Thermal Processing Techniques	14
Thermal Preservation Techniques: Ohmic Heating, Radio Frequency Heating and Microwave Heating: Concept, equipment for treatment, mechanism of microbial inactivation and its application in food preservation. Non Thermal Preservation Techniques: HPP, Ozone, PEF, Cold Plasma, Irradiation, Ultrasound, UV and Oscillating Magnetic Field in food processing.	
Module-4: Green Extraction Techniques	10
Supercritical fluid extraction- concept, property of near critical fluids and super critical fluids, extraction methods and application in food processing. Ultrasonic assisted extraction, microwave assisted extraction, Enzyme assisted extraction, Sub-critical water extraction technology and their application in food industry.	
Module-5: Novel Techniques in Food Processing	8
Advanced Extrusion Technology, Encapsulation and Nano encapsulation, 3D Food Printing, Cryo-processing of foods, Cryogenic grinding, Cryogenic freezing, Atmospheric Pressure Plasma Technology, Application of Process Analytical Technology (PAT) and AI in Food Processing	

Reference books and suggested readings

Title	**Author**
Emerging Technologies for Food Processing.	Da-Wen Sun, 2015
Novel Food Processing Technologies	M. P. Cano, M. S. Tapia, and G. V.
Introduction To Food Engineering	R. P. Singh
Innovation in Food Engineering: New Techniques and Products	Maria Laura Passos, Claudio P. Ribeiro
Food Processing Technology (Principles and Practice)	P. Fellows

		L	T	P	C
NFT-403	**Specialty Foods**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course are to impart-

- To introduce the concept, classification and significance of specialty foods and understand their role in nutrition, culture, economy.
- To impart knowledge on the formulation of therapeutic specialty diets for various disorders.
- To understand the development of specialty foods tailored to different population groups
- To equip students with knowledge of conventional and emerging processing techniques for specialty foods.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the concept, scope, and classification of specialty foods and their role in immunomodulation.	Understand
CO-2	Discuss the recommended diet for cardiovascular, metabolic, and endocrinal disorders	Understand
CO-3	Discuss the recommended diet for GI, Renal, Hepatic, Cancer, and Allergies	Understand
CO-4	Demonstrate the development of specialty food products tailored to nutritional needs of special groups	Understand & Apply
CO-5	Demonstrate the various processing techniques and quality attributes of specialty foods.	Apply

CO-PO Mapping

COs	**Pos**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	-	1	-	-	2	1	-	-	-	2	-	-
CO-2	1	-	1	-	-	2	1	-	-	-	2	-	-
CO-3	1	-	1	-	-	2	1	-	-	-	2	2	-
CO-4	1	1	2	-	-	2	2	1	1	-	2	1	1
CO-5	1	1	2	-	-	2	2	1	-	-	2		
Average	1	1	1.4	-	-	2	1.4	1	1	-	2	1.5	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Concept and scope of Specialty Foods
- Classification of Specialty Foods
- Role of bioactive foods in immunomodulation
- Economic and cultural significance of specialty foods

Course Outcome-2 (CO-2)

- Therapeutic diets and their role in immune boosting
- Recommended Diet for cardiovascular diseases
- Recommended Diet for diabetes mellitus

➢ Recommended Diet for obesity and metabolic disorders
Course Outcome-3 (CO-3)
➢ Recommended Diet for GI disorders
➢ Recommended Diet for Hepatic disorders
➢ Recommended Diet for Cancer
➢ Management of food allergies and intolerances
Course Outcome-4 (CO-4)
➢ Specialty foods for infants, children, and adolescents
➢ Specialty foods for Pregnancy and Lactation
➢ Consumer-oriented specialty foods
➢ Advanced Specialty Foods
Course Outcome-5 (CO-5)
➢ Conventional and Non-conventional Processing techniques for specialty foods
➢ Sensory and quality attributes and calculation of calorific value
➢ Safety and Packaging considerations
➢ Market Trends and Innovations

SYLLABUS

Module-1: Introduction to Specialty Foods	**No. of Hours**
Concept and scope of Specialty foods; Source-based classification of specialty foods; Proprietary foods; Supplementary foods; Genetically modified foods and Transgenic foods; Bioactive foods and their role in immunomodulation, and inflammation; Role of specialty foods in nutrition, Culture, and economy.	8
Module-2: Diets for Cardiovascular, Metabolic, and Endocrine Disorders	
Diet in hypertension, atherosclerosis, congestive heart failure; Therapeutic diets: DASH, Mediterranean, low-sodium, cholesterol-lowering; Diet in diabetes mellitus (Type I & II): Glycemic index/load, carb exchanges, sugar substitutes; Diet in obesity and metabolic syndrome: Low-calorie, high-fiber, low-fat, keto; Functions of bioactive compounds: omega-3, fiber, flavonoids, plant sterols	10
Module-3: Diets for GI, Renal, Hepatic, Cancer, and Allergies	
GI disorders: peptic ulcer, constipation, celiac disease (gluten-free diets); Renal disorders: nephritis, CRF – low-protein, low-sodium/potassium diets; Hepatic disorders: cirrhosis, hepatitis – high-protein, fat-modified diets; Diet in cancer and chemotherapy: High-protein, immune-boosting diets; Management of food allergies and intolerances: lactose-free, nut-free, egg-free, casein-free foods.	8

Module-4: Specialty Foods for special groups and Advanced Specialty Foods	
Infants and Children: Breastfeeding, weaning foods, infant formulas, fortified foods; Adolescents: Energy and micronutrient needs, anaemia-prevention foods; Pregnancy and Lactation: Nutrient-dense diets, folic acid, calcium, iron-rich specialty foods; Geriatric Nutrition: High fibre diet; Athletes and Performance Nutrition: Protein shakes, hydration beverages, energy bars; Advanced Specialty Groups: Designer foods, Space foods.	10
Module-5: Specialty Foods and their Processing Techniques	
Processing techniques of specialty foods: Conventional (fermentation, aging, cold smoking, infusion, sun drying) and Non-conventional (High pressure processing, Pulsed electric fields, cold plasma), Sensory profiling and quality attributes, Calorific value, Safety, shelf-life, and packaging considerations, market trends and innovations, regulatory aspects (FSSAI, Codex, FDA).	10

Reference books and suggested readings

Title	**Author**
Specialty Foods- Processing technology, quality, and safety	Yanyun Zhao. 2012
Functional Foods - Concept to Product.	Gibson GR & William CM. 2000
Handbook of Nutraceuticals and Functional Foods.	Robert EC. 2006
Textbook of Human Nutrition. Oxford & IBH.	Bamji MS, Rao NP & Reddy V. 2003

		L	T	P	C
NFT – 404	**APPLICATION OF COMPUTER IN FOOD PROCESSING**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course are to impart-

- Basic knowledge about the different parts of the computers and their functions
- The knowledge of computer-based instrumentation and process control
- Basic knowledge of modeling and simulation

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the basic components of the computer and their functions	Understand
CO-2	Discuss the basic concepts of statistical analysis	Understand
CO-3	Interpret the concepts of computer-based process control	Apply
CO-4	Demonstrate the modeling and simulation of data set	Apply
CO-5	Examine the data using new software tools	Analyze

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	2	-	-	-	-	-	-	-	-	-	1	1	1
CO-2	2	2	1	1	3	-	-	-	-	-	1	3	1
CO-3	3	3	1	1	2	-	-	-	-	-	1	3	1
CO-4	3	1	1	1	1	-	-	-	-	-	1	1	1
CO-5	3	2	1	1	-	1	-	-	-	-	1	1	1
Average	**2.6**	**2**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	1	**1.8**	**1**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Different components of a computer
- Functions of CPU
- Different storage devices and their functions
- Different input and output devices
- Features of operating systems

Course Outcome-2 (CO-2)

- Importance of data analysis
- Types of data
- Statistical analysis
- Hypothesis testing, ANOVA

Course Outcome-3 (CO-3)

- Determination of regression coefficients
- Linear regression in EXCEL
- Non-linear regression using MATLAB

Course Outcome-4 (CO-4)

➢ What is modelling?		
➢ Types of modelling		
➢ Characteristics of different models		
➢ Kinetic Modelling		
Course Outcome-5 (CO-5)		
➢ Application of AI and ML in process optimization		
➢ Application of RSM in Product development		
➢ Application of fuzzy logics in sensory analysis		
➢ Application of Numerical methods in food process modelling		
SYLLABUS		
Module-1: Basics of Computer software and Hardware		**No. of Hours**
Introduction to computer hardware and operations, CPU, input and output devises, memory, secondary storage, operating system, spreadsheet fundamentals, data base management, graphics application		8
Module-2: Basics of Statistical Analysis		
Classical and recently developed statistical procedures, basic principles of statistical inference, Problems of estimation, hypothesis testing, large sample theory, probability, regression-linear and nonlinear		8
Module-3: Instrumentation and process control		
Computer based instrumentation for data acquisition and their control, virtual instruments, reliability and fault finding, concept of process control -first order, second order, and third order processes		8
Module-4: Modelling and simulation		
Concept, advantages and limitations of dimensional analysis, Models - Types of models and modelling approaches, features of models, Curve fitting method of least squares, estimation of coefficients of simple determination		8
Module-5: New techniques of computation		
Response surface methodology, artificial neural network, artificial intelligence and machine learning (AI/ML), MATLAB, R software, fuzzy logic, genetic algorithm, finite difference, finite element, computational fluid dynamics: concepts and their application in food processing with examples.		8
Reference books and suggested readings		
Title	**Author**	
Elements of Practical Statistics	Kapur, K.	
Basic Statistics	Simpson, O.J.	
Computer Applications in Food Technology	Paul Singh R	
PC based Instrumentation and control	Mike Tooley	
Design and analysis of experiments	Douglas C. Montgomery	

		L	T	P	C
NFT – 405	**FLAVOUR TECHNOLOGY**	**3**	**1**	**0**	**4**

Course Objectives: The objectives of this course are to impart-

- To enable the student to understand the basics of foods flavors
- To enable the student to learn the biosynthesis of natural flavors
- To enable the students to learn the isolation of flavoring compounds techniques from different food materials.
- To enable the students to learn the identification and quantification of flavoring compounds by different analytical techniques.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the fundamentals and perception of food flavors	Understand
CO-2	Discuss the biogenesis of food flavors and demonstrate the formation of flavors during processing	Apply
CO-3	Explain the development of flavor formulations for commercial use	Understand
CO-4	Discuss and execute various techniques for flavor analysis	Apply
CO-5	Explain and implement various techniques for flavor extraction and encapsulation.	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	1	-	-	-	1	-	-	1	-	1	2	2
CO-2	1	1	1	-	-	1	-	-	-	-	1	2	2
CO-3	2	1	2	1	-	2	-	-	-	-	2	3	1
CO-4	3	2	3	2	1	2	1	-	2	-	3	3	3
CO-5	3	2	3	2	2	3	2	1	2	2	3	3	3
Average	**2**	**1.4**	**2.2**	**1.6**	**1.5**	**1.8**	**1.5**	**1**	**1.6**	**2**	**2**	**2.6**	**2.2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Fundamentals of flavors
- Perception of food flavors
- Off flavors in food and their impact on food quality
- Legal issues associated with flavor development

Course Outcome-2 (CO-2)

- Biogenesis of natural flavor
- Mechanism of flavor development during processes
- Pathways of flavor formation
- Identification of flavoring compounds

Course Outcome-3 (CO-3)	
➢ Food Sources as flavors	
➢ Methods of Flavor development	
➢ Flavor emulsions and stabilization	
Course Outcome-4 (CO-4)	
➢ Sensory evaluation of flavors	
➢ Instrumental analysis of flavors using chromatography	
➢ Advanced methods for flavor analysis	
Course Outcome-5 (CO-5)	
➢ Methods of flavor isolation, separation, and extraction	
➢ Flavor encapsulation and its application	
➢ Food flavor and packaging interaction	
SYLLABUS	
Module-1: Introduction of Flavor components	**No. of Hours**
Definition of flavor, classification of food flavor, chemical compounds responsible for flavors, Natural and artificial flavors, Perception of taste and aroma, Gustation and Olfaction, gustatory receptors, Types of taste and their perception, perception of odour in mouth and nose. Off-flavors in foods, and legal issues.	08
Module-2: Biogenesis of Flavors	
Generation of Flavors by carbohydrate, lipids, and protein metabolism. Volatile and non-volatile flavouring compounds, Role of primary and secondary metabolites in flavour generation in food. Thermal Breakdown of sugars, General overview of the pathways for flavour formation via the Maillard reaction, Lipid breakdown, and Lignin degradation. Effect of non-thermal techniques on flavour in comparison to thermal techniques.	10
Module-3: Flavor development during food processes	
Formulations of flavors, Flavor emulsions and stabilization, Flavors production in fermented foods, Dairy flavors, Spices and spice-based products as flavors, Plantation crops as flavors- tea, coffee, cocoa and vanilla, Flavor generation through genetic engineering.	10
Module 4: Analytical techniques for flavors	
Sensory evaluation, selection of flavorist, discrimination analysis, descriptive analysis, Instrumental analysis (Absorption Spectroscopy (UV/VIS), gas chromatography, mass spectrometry, flavor analysis by HPLC), Electronic noses, electronic tongue.	08
Module-5: Flavor extraction and encapsulation	
Methods of flavor extraction, isolation, separation and equipment, Solid phase micro extraction, Principles and techniques of flavor encapsulation, types of encapsulations, factors affecting stabilization of encapsulated flavor and their applications in food industry. Packaging and flavor compounds interaction.	10

Reference books and suggested readings	
Title	**Author**
Food Flavorings. 2nd Ed. Blackie.	Ashurst PR. 1994.
Food Flavor Technology. Sheffield Academic Press.	Taylor A. 2002

Fenaroli's Handbook of Flavor Ingredients.5th Ed.	Burdock GA. 2004
Handbook of Flavor, Characterization: Sensory Analysis, Chemistry and Physiology.	Deibler D & Delwiche J. 2004
Flavor Chemistry and Technology. AVI Publications	Heath HB & Reineccius G.1986

		L T P C
NFT-406	**Nanotechnology in Food Applications**	**3 1 0 4**

Course Objectives: The objectives of this course are to impart-

- To introduce the fundamental concepts of nanotechnology and nanomaterials.
- To explore the applications of nanotechnology in food processing, packaging, preservation, and safety.
- To understand the mechanisms of nano-encapsulation for bioactive delivery.
- To study the interaction of nanomaterials with food components and biological systems.
- To familiarize students with regulatory, safety, and ethical aspects of using nanotechnology in the food sector.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Describe the fundamentals of nanotechnology and its relevance to food systems	Understand
CO-2	Explain characterization techniques and functional roles of nanomaterials in food processing	Understand
CO-3	Implement the process of nanoencapsulation for targeted nutrient delivery	Apply
CO-4	Describe concept of nano-enabled packaging in food systems	Understand
CO-5	Discuss the toxicological and regulatory aspects of nanomaterials	Understand

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	-	2	-	-	-	-	1	1	1	-	1	-	-
CO-2	-	2	-	-	1	1	1	1	3	2	2	-	-
CO-3	-	2	2	1	3	2	1	1	2	2	2	2	1
CO-4	-	2	1	1	3	1	1	1	3	2	2	1	1
CO-5	-	-	1	1	1	2	1	1	2	2	3	2	2
Average	**-**	**2**	**1.33**	**1**	**2**	**2**	**1**	**1**	**2.2**	**2**	**2**	**1.67**	**1.33**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Define nanotechnology in food context
- Top-down vs. bottom-up methods
- Importance of surface area ratio
- Types of nanomaterials in foods

Course Outcome-2 (CO-2)

- Characterization of nanoparticles
- Compare nano-clay and silver particles
- Pros and cons of nano-additives
- Nanosensors for spoilage detection

Course Outcome-3 (CO-3)

- Compare encapsulation techniques
- Predict nano-system stability
- Design omega-3 nano system

Course Outcome-4 (CO-4)

- Explain active/intelligent packaging
- Barrier properties of nanofilms

➢ Biopolymer nanocomposites for food	
➢ Analyze nano-silver film safety	
➢ Design RFID-based nano packaging	
Course Outcome-5 (CO-5)	
➢ Health risks of nanoparticles	
➢ Migration standards by regulators	
➢ Regulatory gaps in India	
➢ Framework for safety evaluation	
SYLLABUS	
Module-1: Introduction to Nanotechnology in Food Systems	**No. of Hours**
Basics of nanoscience and nanotechnology: Definitions, scope, and relevance in food systems; Classification and types of nanomaterials, organic, inorganic, natural, synthetic, nanoemulsions, dendrimers, nanoclays, nanotubes, etc.; Nanofabrication techniques: Top-down and bottom-up approaches; Nanoemulsions	08
Module-2: Characterization and applications of nanoparticles	
Characterization techniques: XRD, SEM, Spectroscopic techniques; Nanostructured ingredients for functional and fortified foods; Nanosensors in food processing and storage; Case studies on nano-based interventions in beverages, bakery, dairy, and nutraceuticals.	08
Module-3: Nanoencapsulation and Targeted Delivery Systems	
Smart delivery systems for nutrients; Principles of encapsulation and controlled release systems; Techniques for nanoencapsulation: Spray drying, coacervation, nano-liposomes, nano-gels; Delivery of nutraceuticals, probiotics, and bioactives; Case studies: Curcumin, omega-3 fatty acids, vitamins, essential oils.	08
Module-4: Nano-enabled Food Packaging	
Active and intelligent packaging: Antimicrobial coatings, oxygen scavengers, and freshness indicators; Biopolymer-based nanocomposites for sustainable packaging; Migration and toxicity of nanoparticles from packaging into food; Real-time monitoring using nano-biosensors and RFID integration.	08
Module-5: Safety, Toxicological Concerns, and Regulatory Aspects	
Risk assessment and toxicological studies of nanomaterials; Interaction with human cells and gut microbiota; Ethical issues, consumer perception, and labelling; National and international regulations (FSSAI, FAO/WHO, EFSA, FDA); Guidelines for responsible development and commercialization.	08

Reference books and suggested readings

Title	**Author**
Novel Approaches of Nanotechnology in Food	Alexandru Grumezescu
Nanotechnology in the Agri-Food Sector	Ranjan, S., Dasgupta, N., & Lichtfouse, E
Nanotechnologies in Food	Chaudhry, Q. et al.
Nanotechnology for Food Applications	Barba, F. J., et al.

		L	T	P	C
NFT – 407	**FOOD PROCESSING WASTE MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart/-

- Knowledge of standards and acts for protecting the environment during food processing
- Knowledge of by-products obtained during food processing and their utilization
- Design and develop waste treatment protocol for different food wastes during processing of food.
- To describe different advanced treatment methods used in industrial waste water treatment.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Describe about Environment Protection Act, food waste and waste management, standards of food processing wastes	Understand
CO-2	Explain about by-products obtained from different food Processing industries and their utilization	Understand
CO-3	Demonstrate various Physico-chemical methods for food Industry effluents	Apply
CO-4	Implement Biological Oxidation Industrial wastewater treatment and management by	Analyze
CO-5	Describe and interpret advanced technological aspects for wastewater treatment of food processing industries.	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	2	1	1	1	1	3	2	3	2	2	2	2	3
CO-2	3	2	1	1	1	2	1	2	2	2	2	3	2
CO-3	3	2	2	1	1	2	1	2	2	3	2	2	1
CO-4	3	2	2	3	2	3	2	3	3	3	2	3	3
CO-5	3	3	2	2	2	3	2	2	2	2	2	3	3
Average	**2.8**	**2.0**	**1.6**	**1.6**	**1.4**	**2.6**	**1.8**	**2.4**	**2.2**	**2.4**	**2.0**	**2.6**	**2.4**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Introduction about waste, Global warming, Impact of green house gases on environment.
- Introduction of food industry wastes and their treatment
- Concept of ISO14001 standards and the Environment Protection Act,1986
- Management of food processing wastes

Course Outcome-2 (CO-2)

- By-products characterization and utilization of cereal, pulses, oilseeds and similar processing industries.
- By-products characterization and utilization of milk and other dairy products, meat, fish, egg and poultry processing industries
- By-products characterization and utilization of fruits and vegetables processing industries.
- By-products characterization and utilization of sugar based processing industries.

Course Outcome-3 (CO-3)

- Concept of food Industry effluents from various plants.
- Unit concept of treatment of food industry effluent.

➢ Environmental pollution and their treatment.	
Course Outcome-4 (CO-4)	
➢ Concept of biological oxidation	
➢ Aeration devices systems	
➢ Advanced modifications of aeration devices systems	
Course Outcome-5 (CO-5)	
➢ Advanced wastewater treatment systems	
➢ Membrane technology	
➢ Physico-chemical separations	
➢ Disinfection and handling disposal of sludge	
SYLLABUS	
Module-1: Food waste classification and Management, Standards and Acts	**No. of Hours**
Waste and their classifications, green house gases, global warming, Impact of waste on environment, ISO 14001 standards, Standards for emission or discharge of environmental pollutants from food processing Industries as per Environment Protection Act, 1986, Food industry wastes, Food waste treatment and disposal, Elements of importance in the efficient management of food processing wastes, concept of Zero waste	8
Module-2: Upcycling of food processing waste and sustainability	
Concept of circular economy, Characterization and utilization/disposal of waste and by-products from cereal, pulses, oilseeds, fruits and vegetables, plantation products, sugar based products, fermented foods, milk and dairy products, fish, meat, egg and poultry processing and other food industries. Value addition from waste or by-products. Food packaging waste disposal, Newer advancements. Extended Producer Responsibility (EPR), Environmental, social and governance	8
Module-3: Industrial wastewater treatment and management by Physico-chemical methods	
Characterization of food Industry effluents, Physical and chemical parameters, Oxygen demands and their interrelationships, Residues(solids), Fats, Oils and grease, Forms of nitrogen, sulphur and phosphorus, Anions and cations, Surfactants, Color, Odor, Taste, Toxicity, Unit concept of treatment of food industry effluent, Screening, Sedimentation/Floatation as pre and primary reactants. Newer developments.	8
Module-4: Industrial wastewater treatment and management by Biological Oxidation	
Objectives, Organisms, Reactions, Oxygen requirements, Aeration devices Systems: Lagoons, Activated sludge process, Oxidation ditches, Rotating biological contactors: their design and variations and advanced modifications, Recent trends.	8
Module-5: Advanced Wastewater Management	
Waste water treatment systems, Physical separations, Micro-strainers, Filters, Ultra filtration and reverse osmosis, Physico-chemical separations: activated carbon adsorption, Ion-exchange electro dialysis and magnetic separation, Chemical oxidation and treatment coagulation and flocculation, Disinfection, Handling disposal of sludge. Recent developments in advanced wastewater treatment and cost economy.	8

List of Text Books/ Reference Books	
1	Waste water Engineering; Treatment and Reuse, Metcalf & Eddy, Fourth Edition, Tata McGraw-Hill Edition
2	Waste water treatment for pollution Control and Reuse, Soli. J Arceivala & Shyam. R Asolekar Third Edition, Tata McGraw-Hill Edition, 2006.
3	Arvanitoyannis I., Waste Management for the Food Industries, 1st Edition, Academic Press, 2007.
4	Lawrence K.Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis, Waste Treatment in Food Processing Industries, Taylor and Francis, 2005.
5	Hand book of Waste management and co-product recovery in Food Processing–Vol.1-Keith Waldron, 2009.

		L	T	P	C
NFT-409	**Food Supply Chain Management**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart-

- To provide students with a comprehensive understanding of the structure and operations.
- To provide students about the challenges of food supply chains**,** including perishability, traceability, and quality assurance from farm to fork.
- To provide students with insights into national and international agri-logistics policies and their effective implementation.
- To promote understanding of sustainability practices, green supply chain initiatives.

Course Outcomes: On the successful completion of the course, students will be able to

CO1	Explain the principles and key characteristics of food supply chains.	Understand
CO2	Discuss the fundamental concepts of agri-food supply chain structure	Understand
CO3	Explain & interpret the logistics and cold-chain strategies for perishable food commodities.	Apply
CO4	Implement the concept of quality assurance, traceability, and safety systems in food supply chains	Apply
CO5	Describe the regulatory framework and global trends of supply chain	Understand

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	1	-	-	-	-	1	-	-	-	-	1	2	1
CO2	1	-	-	-	1	1	-	-	-	-	1	1	1
CO3	1	-	1	-	1	2	-	1	-	-	1	2	2
CO4	1	-	1	-	1	2	-	1	-	1	2	1	1
CO5	1	-	1	-	-	2	1	1	-	1	2	1	1
Average	**1**	**-**	**1**	**-**	**1**	**1.6**	**1**	**1**	**-**	**1**	**1.4**	**1.4**	**1.2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Definition of Food Supply Management
- Role of GMP, GHP and GAP
- Challenges of logistics and supply chain

Course Outcome-2 (CO-2)

- Overview of agri-food supply chain
- Storage systems of agri-food
- Issues in Vegetable Supply chain
- Chain structure: farm to retail

- **Course Outcome-3 (CO-3)**
- Cold Chain infrastructure and logistics

➢ Material handling systems	
➢ Supply Chain network and transport mode optimization	
➢ Digitization in food supply chain	
➢ **Course Outcome-4 (CO-4)**	
➢ Role of packaging in ensuring food preservation	
➢ Traceability and Recall Systems	
➢ Reverse Supply Chain	
➢ Food Chain Risk Management	
Course Outcome-4 (CO-5)	
➢ Agri-logistic policies and their implementation	
➢ Sustainability in food supply chains and Green supply chain	
➢ Regulatory framework and compliance in food supply chains	
SYLLABUS	
Module 1: Introduction to Food Supply Chains	**No. of Hours**
Food supply chain: Definition, Types of food supply chain, Role of GMP, GHP & GAP in Food Supply Chain, Role and Challenges of Logistics and supply chain management in the food industry.	08
Module 2: Fundamentals of Agri-food supply chain	
Concepts of Agri-food supply chain, Storage systems of Agri-food: silos, bins, refrigerated and controlled atmosphere storage; Interdepartmental linkage, Issues in interface complexities of vegetable supply chain, perishability, seasonality, and traceability. Chain structure: farms to retail, inventory types, and node functions; KPIs: fill rate, lead time, damage/loss rates, order cycle time	08
Module 3: Cold Chain Logistics for Perishable products	
Material handling systems: bulk solids, fluids, perishables; Cold-chain infrastructure: refrigerated trucks, thermal insulation, temperature monitoring; Transport mode optimization and routing for perishable logistic. Digitalization & Technology in Food Supply Chain;	08
Module 4: Packaging, Quality, and Traceability Systems	
Role of packaging in logistics efficiency and preservation; Smart packaging: QR codes, sensors, RFID (TTIs); ICT for traceability, recall systems, risk detection and hazard control. Export and import packaging and labelling details, Reverse Supply Chain, Food Supply Chain Risk Management and Mitigation Strategies, Traceability and Blockchain technology.	08
Module 5: Supply Chain Analytics, Sustainability and Policy	
Agri-logistics policies and their implementation, Lean SCM in Indian context, Regulatory Frameworks and Compliance in Food Supply Chains; Global Trends and Innovations in Food Supply Chains; Industry-Based Case Studies; Sustainability and circular economy in Food Supply Chains, Green Supply Chains.	08

Reference books and suggested readings	
Title	**Author**
Designing and Managing the Supply Chain, McGraw-Hill	Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E.
Supply Chain Management: Strategy, Planning & Operation, Pearson.	Chopra, S. & Meindl, P.
Food Supply Chain Management and Logistics: From Farm to Fork, Kogan Page.	Dani, S
Handbook of Food Preservation, CRC Press.	Rahman, S. M.

List of Text Books/ Reference Books	
1	Waste water Engineering; Treatment and Reuse, Metcalf & Eddy, Fourth Edition, Tata McGraw-Hill Edition
2	Waste water treatment for pollution Control and Reuse, Soli. J Arceivala & Shyam. R Asolekar Third Edition, Tata McGraw-Hill Edition, 2006.
3	Arvanitoyannis I., Waste Management for the Food Industries, 1st Edition, Academic Press, 2007.
4	Lawrence K.Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis, Waste Treatment in Food Processing Industries, Taylor and Francis, 2005.
5	Hand book of Waste management and co-product recovery in Food Processing–Vol.1-Keith Waldron, 2009.

		L	T	P	C
NFT-411	**Total Quality Management**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart-

- To provide an understanding of the basic concepts of Quality
- To develop a comprehensive understanding of the quality principles of Total Quality Management
- To impart knowledge of different tools and techniques of TQM.
- To enable learners to apply TQM concepts specifically within the food technology sector

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the concepts of quality management	Understand
CO-2	Describe the basic framework of total quality management	Understand
CO-3	Discuss the various approaches of total quality management	Understand
CO-4	Demonstrate the tools and techniques used in total quality management	Apply
CO-5	Implement various total quality management systems in the food industry	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	-	-	-	-	-	-	2	2	1	-	1	-	-
CO-2	-	1	-	-	1	-	1	2	2	-	1	-	-
CO-3	-	1	-	-	1	-	1	3	3	2	2	-	-
CO-4	-	1	2	2	3	1	1	3	2	-	2	2	-
CO-5	-	1	2	2	3	1	1	3	3	2	3	1	1
Average	**-**	**1**	**2**	**2**	**2**	**1**	**1.2**	**2.6**	**2.2**	**2**	**1.8**	**1.5**	**1**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Fundamentals of quality
- Contributions of quality pioneers
- Need and dimensions of quality
- Customer-focus orientation

Course Outcome-2 (CO-2)

- Evolution of quality control
- Modern framework of TQM
- Effective communication in TQM
- Barriers to TQM

Course Outcome-3 (CO-3)

- Various approaches of TQM
- Continuous process improvement
- Strategic quality planning
- Concepts of teamwork

Course Outcome-4 (CO-4)	
➢ Various tools/techniques of TQM	
➢ Requirements of reliability	
➢ Quality functions development	
➢ Various diagrams for quality measurement	
Course Outcome-5 (CO-5)	
➢ Significance and benefits of ISO	
➢ Quality auditing methods	
➢ Concepts of documentation	
➢ Implementation of TQM in the Food Industry	
SYLLABUS	
Module-1: Introduction to Quality Management	**No. of Hours**
Evolution and definition of quality; Need and dimensions of product and service quality; Contributions of quality pioneers – Deming, Juran, Crosby, Feigenbaum, Ishikawa, and Taguchi; Quality statements and philosophies; Customer focus – orientation, satisfaction, complaints, and retention; Cost of quality.	**08**
Module 2: Framework of TQM	
Basic concepts and modern framework of TQM; Evolution of quality control and its transformation to TQM; Competitiveness and customer-centric approach; Building quality chains and integrating quality into design; Communication in TQM – strategy, message, types; Effective communication, employee empowerment, involvement, training and teamwork. Barriers to TQM implementation.	**08**
Module-3: Various Approaches of TQM	
Leadership, Strategic Quality Planning, Quality Councils, Employee Involvement, Motivation, Empowerment, Team and Teamwork, Quality Circles Recognition and Reward, Performance Appraisal, Continuous Process Improvement, PDCA Cycle, 5S, Kaizen, Supplier Partnership, Partnering, Supplier Selection, Supplier Rating.	**08**
Module-4: Tools, Techniques & Selection	
Quality Functions Development (QFD), Benefits, Voice of Customer, Information Organization, House of Quality (HOQ), Building a HOQ, QFD Process, Taguchi Method and Quality Loss function, Failure Mode Effect Analysis (FMEA): Requirements of Reliability, Failure rate, Total Productive Maintenance (TPM). New Management Tools for Process Improvement, Six Sigma Methodologies; Fishbone Chart, PERT Chart; 7QC tools and selection.	**08**
Module-5: Quality Management Systems	
Introduction, Benefits of ISO Registration, ISO 9000 Series of Standards, ISO 9001, Requirements, Implementation, Documentation, Writing the Documents, Quality Auditing, TQM Culture, Quality Auditing, QS 9000, ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in Food Industry	**08**

Reference books and suggested readings	
Title	**Author**
Total Quality Management	Lt. Gen. H. Lal
Total Quality Management	Sage Sharma
Total Quality Management – Text and Cases	Janakiraman. B and Gopal.R.K
The Management and Control of Quality	JamesR. Evans and William M. Lindsay

		L	T	P	C
NFT – 413	**FOOD PRODUCT AND PROCESS DEVELOPMENT**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart-

- Strategic, technical and commercial aspects of new food product development.
- Knowledge of market research, consumer insights, and innovation frameworks.
- Knowledge to critically analyze formulations; process development and go-to-market strategies for new food products.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Describe the fundamentals of innovation and structured product development processes.	Understand
CO-2	Interpret the market analysis, consumer trends and design thinking to food product development.	Apply
CO-3	Examine the technical and economic feasibility of new food product development	Analyze
CO-4	Demonstrate the development of food formulations & shelf life study	Apply
CO-5	Implement marketing strategies for the launch of newly developed products	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	-	1	-	1	2	-	-	-	-	2	-	1
CO-2	1	2	3	2	1	1	-	2	-	3	2	2	2
CO-3	2	2	3	1	3	3	1	2	-	2	3	3	3
CO-4	2	2	3	3	3	3	1	2	-	2	2	3	3
CO-5	-	1	2	2	1	1	1	1	-	1	3	2	2
Average	**1.5**	**1.7**	**2.4**	**2**	**1.8**	**2**	**1**	**1.7**	**-**	**2**	**2.4**	**2.5**	**2.2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

➢ Innovation Concept	
➢ Need for New product development	
➢ Type of New product Developments in Food Industries	
➢ Stage Gate model of New Product Development	
Course Outcome-2 (CO-2)	
➢ Product life cycle	
➢ Markey research tools and techniques	
➢ Identifying opportunities	
Course Outcome-3 (CO-3)	
➢ Idea generation, screening and selection	
➢ Feasibility analysis	
Course Outcome-4 (CO-4)	
➢ Development of process	
➢ Planning of production trials	
➢ Sensory evaluation, Nutritional profiling, shelf life study and quality parameters	
Course Outcome-5 (CO-5)	
➢ Marketing mix	
➢ Test marketing and feedback analysis	
SYLLABUS	
Module-1: Concept of Innovation & Fundamentals of Product Development	**No. of Hours**
Concept of innovation, Need for new product development in the food industry, Types of new products, Stage-Gate model, Role of cross-functional team in NPD	8
Module-2: Market and Consumer Insight	
Product life cycle, Market research tools and techniques, Consumer behavior, preference mapping, Competitive product benchmarking; Identifying opportunity areas using design thinking and trend analysis	8
Module-3: Product Conceptualization and Feasibility	
Idea generation methods: brainstorming, SCAMPER, mind mapping, Screening, and scoring models for idea selection, technical feasibility, Economic viability: cost estimation, pricing strategies, value proposition	8

Module-4: Product Formulation and Quality	
Development of process and planning for production trials, Sensory evaluation, nutritional profiling, shelf-life considerations, Labeling requirement, Quality parameters, food safety, and regulatory compliance	8
Module-5: Commercialization and Launch Strategy	
Packaging development and labeling design, Marketing mix for food products, Test marketing and feedback analysis, Launch planning, product positioning and success metrics	8

Reference books and suggested readings

Title	**Author**
Food product development	Earle, M., Earle, R., & Anderson, A.
Hydrocolloids: Practical Guides for the Food Industry	Hoefler, A.C.
Food Processing Technology	P.J Fellows
Food Product Development: Based on Experience	Side, C.
New Food Product Development: From Concept to Marketplace	Fuller, G.W.

		L	T	P	C
NFT-415	**Food Traceability, Authenticity and Recall**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart -

- To understand the fundamentals of food traceability, authenticity, and recall
- To understand systems and technologies for traceability and Unique identification
- To apply analytical methods for authenticity and emerging technologies
- To evaluate applications, food recall systems and trends of traceability systems
- To apply risk assessment and crisis management in food recalls

Course Outcomes: Upon the successful completion of the course, students will be able to-

CO-1	Describe the fundamental principles and the importance of food traceability and authenticity.	Understand
CO-2	Describe different systems and technologies used for traceability.	Understand
CO-3	Interpret analytical methods for detecting food authenticity and adulteration.	Apply
CO-4	Discuss the various regulatory frameworks used for traceability.	Understand
CO-5	Implement the different traceability systems in identification of food frauds.	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	3	2	-	-	-	2	-	-	-	-	-	3	-
CO-2	3	3	2	-	2	-	-	-	3	2	2	3	-
CO-3	3	3	2	2	2	-	-	-	3	2	2	3	2
CO-4	3	3	2	-	2	2	2	2	3	2	-	3	2
CO-5	3	3	2	2	2	2	3	2	3	2	2	3	2
Average	**3**	**2.8**	**2**	**2**	**2**	**2**	**2.5**	**2**	**3**	**2**	**2**	**3**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Define food traceability its importance in the modern food industry
- Historical perspective of food adulteration and its impact on food authenticity
- Key concepts of traceability, blockchain, authenticity, integrity, and recall with examples
- Food fraud and its impact

Course Outcome-2 (CO-2)

- Internal and external traceability systems with suitable examples
- Role of barcodes, RFID, QR codes, and blockchain in food traceability
- Data management: key data elements (KDEs) and critical tracking events (CTEs)
- Effectiveness of international standards (GS1, ISO, BRCGS) in ensuring food traceability

Course Outcome-3 (CO-3)

- Sampling methods for authenticity testing in food
- Application of molecular techniques such as DNA barcoding in detecting food adulteration
- Challenges of sensitivity and specificity in analytical methods for food authenticity

• Emerging technologies for authenticity of food
Course Outcome-4 (CO-4)
➢ Legal and regulatory frameworks
➢ Regulatory hurdles faced in the traceability of bioactive and novel foods
➢ Role of traceability in promoting sustainability and reducing food fraud
➢ Managing traceability information
Course Outcome-5 (CO-5)
• Implementing traceability systems in different food sectors
• Food recalls: planning, execution, and communication
• Risk assessment and crisis management in food recalls
• Recent innovations and smart packaging in the context of global food supply chains

SYLLABUS	
Module-1: Fundamentals of Food Traceability and Authenticity	**No. of Hours**
Introduction to food traceability: definitions, scope, and importance, Historical perspective on food adulteration and authenticity, Key concepts: authenticity, blockchain technology, integrity, and recall, Overview of global and national food supply chains, Food fraud: types, causes, and impacts on industry and consumers.	8
Module-2: Systems and Technologies for Traceability and Recall	
Traceability systems: internal vs. external traceability, Unique identification: barcodes, RFID, QR codes, and blockchain, Data management: key data elements (KDEs) and critical tracking events (CTEs), Integration of traceability systems in food processing and distribution, International best practices and standards (GS1, ISO, BRCGS).	8
Module-3: Analytical Methods for Authenticity	
Sampling methods and experimental design for authenticity testing, Physico-chemical, chemical, and molecular techniques (e.g., IRMS, DNA barcoding, chromatography), Microbiological and immunological assays for food authentication, Emerging technologies: spectroscopy, chemometrics, and data analytics, Detection of geographical origin, species, and composition (e.g., PDO, PGI, TSG).	8
Module-4: Regulatory frameworks for Traceability	
Legal and regulatory frameworks (Codex, FSSAI, EU, US FDA, etc.), Role of traceability in food safety and quality assurance, Case studies: major food authenticity scandals and recalls. Managing Traceability Information, Selection of right technology, Traceability Implementation Tools & Resources.	8
Module-5: Implementation of traceability in food systems	
Implementation of traceability and authenticity systems in different food sectors (meat, dairy, grains, oils, etc.), Food recalls: planning, execution, and communication, Risk assessment and crisis management in food recalls, Role of traceability in sustainability and reducing food fraud, Innovations: digital traceability and smart packaging.	8

Reference books and suggested readings	
Title	**Author**
Resources at FSSAI website	FSSAI
Regulatory status of Direct Food Additives	Furia TE
Food Authenticity and Traceability	Michele Lees
Food Traceability and Authenticity: Analytical Techniques	Didier Montet, Ramesh C. Ray
Food Fraud Prevention: Policy, Strategy, and Decision-Making	John W. Spink
Food Authenticity and Traceability: Advances and Emerging Techniques	Gerard Downey

		L	T	P	C
NFT-417	**Food Plant Design & Layout**	**3**	**0**	**0**	**3**

Course Objectives: The objectives of this course are to impart-

- Knowledge of food processing plant layout and design
- To provide knowledge of fundamental challenges to consider for sites, layout selection, and design considerations for a food plant.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Discuss the preliminary requirements and feasibility for establishment of a new product specific food plant	Understand
CO-2	Discuss the criteria for site selection, plant sizing, and feasibility using engineering and economic tools.	Understand
CO-3	Implement process scheduling and layout planning methods for food processing plant	Apply
CO-4	Demonstrate the tools for efficient design of plant layout	Apply
CO-5	Describe safety protocols, hygiene standards and building infrastructure for food plants.	Understand

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	3	1	-	-	2	1	2	1	1	2	2	3	1
CO-2	3	1	1	2	2	1	2	1	1	2	2	3	1
CO-3	3	1	1	2	3	1	2	1	1	2	2	3	1
CO-4	3	1	1	2	3	1	2	1	1	2	2	3	1
CO-5	3	1	1	2	2	1	3	1	1	2	2	3	1
Average	**3**	**1**	**1**	**2**	**2.4**	**1**	**2.2**	**1**	**1**	**2**	**2**	**3**	**1**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Fundamentals of plant layout
- Perishable nature of foods and implications for design
- General technical, legal, economic, safety, and hygiene considerations
- Typical situations giving rise to plant design and redesign problems

Course Outcome-2 (CO-2)

- Steps of feasibility study and preparation of feasibility reports
- Collection of technical and market data; information flow diagrams
- Factors affecting plant location and application of location theory models
- Plant sizing techniques: breakeven analysis, optimization, and production volume estimation

Course Outcome-3 (CO-3)

- Design of food products and product specifications
- Least-cost formulation and ingredient selection
- Process selection: technical, economic, and social aspects
- Process planning, flow sheeting, and development of computer-aided flow diagrams

Course Outcome-4 (CO-4)

- Selection criteria for process, material handling, and service equipment
- Economic evaluation of equipment using cash flow and optimization methods

➢ Plant layout types, symbols, and standards	
➢ Development, evaluation, and optimization of layouts using software tools	
Course Outcome-5 (CO-5)	
➢ Design and planning of utilities: steam, refrigeration, water, electricity, ventilation, drainage	
➢ Planning infrastructure: laboratories, toilets, offices, warehouses, roads, docks	
➢ Worker safety: hazards (fall, electric, fire, chemical), control measures, sanitation and pest control	
➢ Building materials and codes for walls, ceilings, floors, and color-coded piping systems	
SYLLABUS	
Module-I: Fundamentals & Feasibility	**No. of Hours**
Classification of plants; perishability issues; preliminary design considerations (technical, economic, legal, safety, hygiene), Situations triggering redesigns, Feasibility studies: data gathering (air, water requirement etc.), information flow diagrams, market/technical assessment, preparation of feasibility report.	**8**
Module 2: Location & Plant Sizing	
Factors influencing site selection; applying location theory models, Criteria for plant sizing: raw material availability, market demand, ROI, competition, Procedures for estimation of economic plant size (breakeven analysis and optimization) and cost, estimation of volume of production for each product.	8
Module 3: Product & Process Design	
Design of product, product specifications, least cost mix of raw materials, process design, requirement of water and air, Concepts of zoning, process selection considering technical, economic and social aspects. Process planning and scheduling, flow sheeting, flow diagrams and process flow charts including their design and computer aided development of flow charts, Costing of product.	8
Module-4: Equipment Selection & Plant Layout	
Equipment types: process, handling, utilities, instrumentation, controls, Selection criteria: performance, economics, service life, spare parts decisions, Layout types and planning; CAD tools; symbols and standards; space and distance guidelines	**8**
Module-5: Support Infrastructure, Safety & Building Design	
Utilities infrastructure: steam, refrigeration, water, electricity, drainage, CIP, fire safety, Piping design, building/plumbing codes, color coding, Infrastructure planning: labs, offices, canteens, toilets, roads, docks, Safety and health: hazards and controls, hygiene, pest control, sanitation, Building materials and structural design requirement	8

Reference books and suggested readings

Title	Author
Food Plant Design, Taylor and Francis	Antonio Lopez-Gomez, Gustavo V. Barbosa-Canovas (2005)
Plant Layout and Material Handling. Willey eastern Pub.	Apple, J.M. (2000)
Unit Operations of Agricultural Processing, Kalya Publishers, Ludhiana.	Sahay, K.M. and Singh, K. K. (1998)

		L	T	P	C
OFT – 401	**NUTRITIONAL ASPECTS OF NATURAL AND PROCESSED FOODS**	**2**	**0**	**0**	**2**

Course Objectives: The objectives of this course are to impart-

- Knowledge about the nutritional importance of the different constituents of the foods and their digestion and absorption in human body
- Nutrient's role in controlling the physiological processed foods and development of different diets
- Balance & therapeutic diet for different individuals and groups and Assessment of calorific value and nutritional quality of natural and processed foods.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Explain the basic concepts of food nutrition and RDI	Understand
CO-2	Discuss the digestion of nutrients in the human body	Understand
CO-3	Implement and formulate different diets	Apply
CO-4	Describe and calculate calorific value of food	Apply
CO-5	Explain and interpret sensory analysis of food	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	3	-	-	-	-	-	2	-	-	1	1	2	2
CO-2	3	1	1	-	-	-	1	-	-	1	1	2	2
CO-3	3	-	-	-	-	-	1	-	-	1	1	2	2
CO-4	3	2	-	-	-	-	1	-	-	1	1	2	2
CO-5	3	1	1	-	-	-	1	-	-	1	1	2	2
Average	**3**	**1.3**	**1**	**-**	**-**	**-**	**1.2**	**-**	**-**	**1**	**1**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Knowledge about the function of food and diet
- Nutrients and its role in human diet
- Recommended Dietary Intakes (RDI) and its significance

Course Outcome-2 (CO-2)

- Different categories of foods and its sources
- Nutritional changes during processing & storage of foods
- Restoration, Enrichment, Fortification and Supplementation of foods

Course Outcome-3 (CO-3)

- Digestion, Absorption and Metabolism of food nutrients
- Protein & lipid digestion in human body

Course Outcome-4 (CO-4)

➢ Balanced diets for different groups
➢ Therapeutic diets for people in various ailments and disorders
➢ Functional foods and nutraceuticals
Course Outcome-5 (CO-5)
➢ Assessment of calorific value of foods
➢ Nutritional quality of natural and processed foods by different means
➢ Sensory qualities and acceptability of foods

SYLLABUS	
Module-1: Basic concept of nutrients of food & RDI	**No. of Hours**
Food and its functions, Role of nutrients, Effects of deficient or excess intake of the individual essential nutrients. Recommended Dietary Intakes (RDI) and its uses. Factors affecting nutritional requirement of an individual.	8
Module-2: Composition of Foods	
General and Specific for different foods of plant and animal origin. General causes of loss of nutrients. Nutritional changes during processing & storage and their implications. Potentially undesirable constituents in foods. Restoration, Enrichment, Fortification and Supplementation of foods	8
Module-3: Fate of Food in human body	
Digestion, Absorption and Metabolism of Carbohydrate: Glycolytic pathway, TCA cycle, ETP, PPP. Protein & lipid digestion, absorption and metabolism. Digestion, absorption and metabolism of Vitamins and Minerals.	8
Module-4: Therapeutic diet and its role	
Balanced diets for normal individuals, Therapeutic diets for people suffering from various ailments and disorders, Functional foods.	8
Module-5: Nutritional and Sensory qualities of Food	
Assessment of calorific value and nutritional quality of natural and processed foods by chemical and biological means. Sensory qualities and acceptability of foods.	8

Reference books and suggested readings

Title	**Author**
Nutrition and Dietetics	Shubhangini A.Joshi
Nutritive Value of Indian Foods	Gopalan C and others
Food Chemistry'	Fennema O. R
Basic Nutrition in Health & Disease	P.S. Howe & W.B. Saunders
Food and Nutrition	Swaminathan M

		L	T	P	C
NFT – 419	**INDUSTRIAL TRAINING**	**0**	**0**	**4**	**2**

Course Objectives: The objectives of this course are to -

- To provide an exposure to industrial environment
- To acquaint with the various machines for the manufacturing of food products
- To develop critical thinking for solving industrial problems

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand the plant layout, work culture and human relationship.	Understand
CO-2	Apply the theoretical knowledge in understanding the working of various machines and manufacturing processes	Apply
CO-3	Understand the process sequence and optimization of process parameters.	Apply, Analyze
CO-4	To get exposure to various conventional and modern tools and equipment for testing of raw materials and finished products	Analyze
CO-5	To analyze the research problem and devise methodology/ steps to solve it and development of products	Apply, Analyze

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	3	2	-	-	2	3	3	2	2	3	2	2
CO-2	3	2	2	1	2	2	1	2	2	-	3	2	2
CO-3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO-4	3	3	2	3	3	-	-	-	3	-	3	2	2
CO-5	3	3	3	3	3	3	1	3	3	2	3	2	2
Average	**2.6**	**2.8**	**2.4**	**2.25**	**2.75**	**2.25**	**1.75**	**2.5**	**2.4**	**2**	**3**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

		L	T	P	C
NFT – 421	**MINOR PROJECT**	**0**	**0**	**12**	**6**

Course Objectives: The objectives of this course are-

- To identify a research problem of industrial and societal relevance
- To compile the available literature related to selected research problem
- To deliver a presentation consisting of the methodology for solving the problem
- To improve the communication skill of the students.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Review existing literature and identify the research gap in the chosen domain	Understand, Analyze
CO-2	Finalize an appropriate research topic and clearly define research objectives	Apply
CO-3	Design an experimental plan to achieve the defined research objectives	Apply
CO-4	Identify and predict the potential outcomes of the proposed research work	Analyze
CO-5	Compile and present a structured synopsis for the proposed research work	Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	3	-	-	3	-	2	2	1	-	2	3	2	2
CO-2	3	2	2	2	1	2	3	2	3	3	2	2	2
CO-3	3	3	3	2	3	2	3	3	3	3	3	2	2
CO-4	3	2	2	-	2	1	2	3	3	3	3	2	2
CO-5	3	3	3	-	1	2	1	2	1	2	3	2	2
Average	**3**	**2.5**	**2.5**	**2.33**	**1.75**	**2.25**	**1.8**	**2.2**	**2.5**	**2.6**	**3**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

		L	T	P	C
NFT – 423	**SEMINAR**	**0**	**0**	**4**	**2**

Course Objectives: The objectives of this course are to impart-

- Study a topic of latest developments/innovative technology on their own and to prepare a dissertation report on this topic
- Present a lecture on the topic on power point format.
- Improve the communication skill of the students

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Review existing literature related to the selected topic of interest	Understand
CO-2	Organize and present the reviewed literature in the form of a coherent technical report.	Apply
CO-3	Use innovative digital tools and technologies to enhance the quality and effectiveness of seminar presentations	Apply
CO-4	Deliver an effective seminar presentation and respond appropriately to audience queries	Evaluate
CO-5	Participate actively as an audience member by attentively listening to peer presentations, learning from them, and asking relevant questions	Understand, Apply

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	1	3	2	3	3	2	2	-	2	-	2	2	2
CO-2	3	3	2	2	3	2	3	2	2	3	2	2	2
CO-3	3	-	-	-	2	2	2	-	2	3	2	2	2
CO-4	3	-	-	-	-	1	1	2	3	3	1	2	2
CO-5	2	-	1	2	1	2	3	1	3	3	2	2	2
Average	**2.4**	**3**	**1.6**	**2.3**	**2.25**	**1.8**	**2.2**	**1.6**	**2.4**	**3**	**1.8**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

		L	T	P	C
OFT-402	**Fundamentals of Quality & Packaging of Foods**	**2**	**0**	**0**	**2**

Course Objectives: The objectives of this course are to impart-

- To provide fundamental knowledge of food quality attributes and introduce instrumental, chemical, and microbial methods for quality control in food products.
- To introduce the fundamental **principles, functions, and importance of food packaging** in the food industry.
- To familiarize students with **various types of packaging materials** and enable them to compare their properties and applications.
- To provide knowledge about the **specific packaging needs of different food products** based on their characteristics and storage conditions.
- To develop an understanding of traditional and modern packaging systems.
- To equip students with knowledge of **mechanical and functional testing methods** for evaluating the quality and suitability of packaging materials.

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Understand the various quality attributes and factors influencing food quality	Understanding
CO-2	Understand the basic concept of packaging its role and its function	Remembering
CO-3	Understand different types of packaging materials and their advantages and disadvantages	Analyzing
CO-4	Understand the packaging requirements of different types of foods	Applying
CO-5	Understand the various packaging systems and various mechanical & functional tests	Applying

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	-	-	-	-	-	-	-	-	1	1	-	-	-
CO-2	1	1	-	-	-	3	-	1	1	1	2	-	-
CO-3	3	2	3	2	1	3	3	3	2	2	1	2	2
CO-4	2	2	3	2	2	2	2	2	3	2	2	3	2
CO-5	3	2	3	3	2	3	3	3	3	3	3	3	3
Average	**2.2**	**1.7**	**3**	**2.3**	**1.6**	**2.7**	**2.6**	**2.2**	**2**	**1.8**	**2**	**2.6**	**2.3**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome-1 (CO-1)

- Fundamentals of quality
- Importance of quality
- Factors influencing quality
- Statistical Analysis

Course Outcome-2 (CO-2)
➢ Packaging concept
➢ Importance of packaging
➢ Package components
➢ Package labelling
Course Outcome-3 (CO-3)
➢ Various classification packages
➢ Manufacturing of packages
➢ Advantages of package materials
➢ Disadvantages of package materials
Course Outcome-4 (CO-4)
➢ Packaging requirements
➢ Packaging of Fruits & Vegetables
➢ Packaging of Bakery products
➢ Packaging of Beverages
Course Outcome-5 (CO-5)
➢ Packaging Systems
➢ Need of Lamination
➢ Aseptic Packaging
➢ Novel Packaging Techniques

SYLLABUS

Module-1: Fundamentals of Quality	**No. of Hours**
Concept of quality: Definitions, importance & factors influencing food quality. Various Quality attributes of food, Instrumental, chemical and microbial quality control. Sensory Evaluation of food and Statistical control.	08
Module-2: Introduction to Packaging	
Introduction to packaging: Concept of packaging, Role and Functions of packaging, Package components, Printing, Package labelling: Functions and Regulations. Hazards acting during transportation, storage and distribution.	08
Module-3: Package requirements	
Package materials: classification packages, paper as package material its manufacture, types, advantages, corrugated and paper board boxes etc. Glass as package material, manufacture, advantages, disadvantages, metal as package material-manufacture, advantages, disadvantages, aluminum as package material,. Its advantages and disadvantages, plastic as package material, classification of polymers, properties, uses and chemistry of each plastic such as polyethylene, polypropylene, polystyrene, polycarbonate, PVC, PVDC, cellulose acetate, nylon etc	10
Module-4: Packaging of Different Food Products	

Packaging requirements of different types of foods : fruits and vegetables, meat, fish, poultry, dairy products, edible oils and spice products, bakery products, confectioneries, Instant foods, extruded foods, snack foods, alcoholic and nonalcoholic carbonated beverages, compatibility and estimation of shelf life.	8
Module 5: Packaging Systems	
Packaging Systems: Lamination, need of lamination, types, properties, advantages and disadvantages. Vacuum and gas packaging, aseptic packaging, retort packaging, CAP and MAP, active packaging, shrink packaging, edible packaging.	8

Reference books and suggested readings	
Title	**Author**
Food Quality Assurance: Principles & Practice	Inteaz Ali
Principles of Sensory Analysis	M.A Amerine
Food Packaging: Principles & Practice	Robertson G.L
Principles of Food Packaging	Saclarow S. & Griffin R.C.
Food Packaging Materials	Mahadeviah M. & Gowramma R.V.
Novel Food Packaging Techniques	Raija Ahvenainen

		L	T	P	C
NFT – 410	**PROJECT**	**0**	**0**	**24**	**16**

Course Objectives: The objectives of this course are to impart-

- To articulate a clear research question or problem and formulate a hypothesis
- To identify and practice research ethics and responsible conduct in research
- To communicate confidently and constructively with fellow students and faculty as mentors explain their research to others in the field and to broader audiences through research presentation

Course Outcomes: On the successful completion of the course, students will be able to-

CO-1	Conduct experimental work systematically to meet the stated research objectives.	Apply
CO-2	Analyze and interpret the data obtained from experimental investigations.	Analyze
CO-3	Justify the industrial and societal relevance of the Project.	Evaluate
CO-4	Compile results, discussion, and conclusions in the form of a research thesis	Apply
CO-5	Identify suitable conferences and journals for publication of the research work	Analyze

CO-PO Mapping

COs	**POs**											**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO-1	3	-	-	3	-	2	1	-	1	-	2	2	2
CO-2	3	2	2	2	1	2	3	-	2	3	3	2	2
CO-3	3	3	3	2	3	2	2	2	3	3	3	2	2
CO-4	3	2	2	-	2	1	2	3	3	3	3	2	2
CO-5	3	3	3	-	1	2	3	3	2	1	2	2	2
Average	**3**	**2.5**	**2.5**	**2.3**	**1.75**	**1.8**	**2.2**	**2.6**	**2.2**	**2.5**	**2.6**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put "-"