JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

KAKINADA – 533 003, Andhra Pradesh, India

B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

B.Tech. – III Year I Semester

S.No.	Category	Title	L	T	P	Credits
1.	Professional Core	Processing of Milk and Milk Products	3	0	0	3
2	Professional Core	Food Packaging	3	0	0	3
3	Professional Elective-I	Grain Storage Technology Food Biotechnology Food Toxicology	2	0	0	2
4	Open Elective–I	OR Entrepreneurship Development & Venture Creation	3	0	0	3
5	Open Elective–II		3	0	0	3
6	Professional Core	Processing of Milk and Milk Products Lab	0	0	3	1.5
7	Professional Core	Food Packaging Technology and Equipment	0	0	3	1.5
8	Skill Enhancement course	Fermentation Technology	0	1	2	2
9	BS &H	Tinkering Lab	0	0	2	1
10	Evaluation of Community	Community Service Project	-	-	-	2
Total			14	1	10	22
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	3	4.5
MC	Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)		3	0	0	3
HC	Honors Course (Student may select from the same Honors pool)		3	0	0	3
HC	Honors Course (Student may select from the same Honors Pool)		3	0	0	3

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R23 IIIRD YEAR SYLLABUS

B.Tech. – III Year II Semester

S.No	Category	Title	L	T	P	C
1	Professional Core	Processing of Meat, Poultry, Fish and Marine Products	3	0	0	3
2	Professional Core	Unit Operations in Food Engineering	3	0	0	3
3	Professional Core	Food Quality, Safety, Standards and Certification	3	0	0	3
4	Professional Elective-II	• Non-Thermal Operations in Food Engineering • Food Process Equipment Design • Novel Technologies in Food Processing	3	0	0	3
5	Professional Elective - III	• Beverage Technology • Brewing Technology • Flavor Technology	2	0	0	2
6	Open Elective-III		3	0	0	3
7	Professional Core	Processing of Meat, Poultry, Fish and Marine Products Lab	0	0	2	1
8	Professional Core	Unit Operations in Food Engineering Lab	0	0	2	1
9	Skill Enhancement course	Food Product Development	0	1	2	2
10	Audit Course	Technical Paper Writing &IPR	2	0	0	-
Total			1	1	06	21
Mandatory Industry Internship of 08 weeks duration during summer vacation						
MC	Student may select from the same minors pool		3	0	3	4.5
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	0	3
HC	Student may select from the same honors pool		3	0	0	3
HC	Honors Course (Student may select from the honors pool)		3	0	0	3

III Year -I Semester	PROCESSING OF MILK AND MILK PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand about the composition, nutritive value of milk, and products
- To learn the value addition and packaging of milk, and products

Course Outcomes

COs	Statement	Bloom Level
CO1	Basic knowledge on milk composition and nutrients	L2
CO2	Principle of different Pasteurization techniques	L2
CO3	Acquire knowledge on Equipment and Machinery used in milk processing	L2
CO4	Acquire knowledge on cross contamination sources	L4
CO5	Knowledge on Process Technology milk and milk products	L5

Unit – I

Fluid Milk: Composition of milk and factors affecting it. Physico-chemical characteristics of milk and milk constituents. Production and collection, cooling and transportation of milk. Tests for milk quality and Adulteration. **Pasteurization and Sterilization:** Process and equipment for milk pasteurization, direct and indirect sterilization; Ultra - High - Temperature (UHT) sterilization. Fouling of pasteurizers and sterilizers. Aseptic packaging

Unit – II

Homogenizers: principle of operation, design calculation for laminar and turbulent regimes, technology of homogenized milk production. **Technology and standards of commercial liquid milk products**: Toned, Double Toned Products, Reconstituted, Recombined, Standardized and Fermented Milks etc. Dairy Chemistry & Microbiology: Roles of lipids, proteins, carbohydrates, minerals, vitamins and enzymes, importance of psychrophilic, mesophilic and thermophilic spoilage organisms in storage.

Unit – III

Definition, Classification, Composition and physico-chemical properties of Cream. Production processes and quality control. Butter: Definition, Classification, Composition and methods of manufacture, Packaging and storage. Butter oil/Ghee. Ice cream: Definition, Classification and Composition, Constituents and their role. Preparation of mixes and freezing of Ice cream, Overrun, Judging, Grading, and defects of Ice cream.

Unit – IV

Evaporated and Condensed milk: Method of manufacture, Packaging and storage. Defects, Causes, and prevention. Roller and Spray Drying of milk solids. Instantization. Flow ability, Dustiness, Reconstituability, Dispersability, Wettability, Sinkability and appearance of milk powders. Manufacture of Casein, Whey protein, Lactose from milk or use in formulated foods and FSSAI Stndards.

Course Objectives

- To understand about the composition, nutritive value of milk, and products
- To learn the value addition and packaging of milk, and products

Course Outcomes

COs	Statement	Bloom Level
CO1	Basic knowledge on milk composition and nutrients	L2
CO2	Principle of different Pasteurization techniques	L2
CO3	Acquire knowledge on Equipment and Machinery used in milk processing	L2
CO4	Acquire knowledge on cross contamination sources	L4
CO5	Knowledge on Process Technology milk and milk products	L5

Unit – I

Fluid Milk: Composition of milk and factors affecting it. Physico-chemical characteristics of milk and milk constituents. Production and collection, cooling and transportation of milk. Tests for milk quality and Adulteration. **Pasteurization and Sterilization:** Process and equipment for milk pasteurization, direct and indirect sterilization; Ultra - High - Temperature (UHT) sterilization. Fouling of pasteurizers and sterilizers. Aseptic packaging

Unit – II

Homogenizers: principle of operation, design calculation for laminar and turbulent regimes, technology of homogenized milk production. **Technology and standards of commercial liquid milk products**: Toned, Double Toned Products, Reconstituted, Recombined, Standardized and Fermented Milks etc. Dairy Chemistry & Microbiology: Roles of lipids, proteins, carbohydrates, minerals, vitamins and enzymes, importance of psychrophilic, mesophilic and thermophilic spoilage organisms in storage.

Unit – III

Definition, Classification, Composition and physico-chemical properties of Cream. Production processes and quality control. Butter: Definition, Classification, Composition and methods of manufacture, Packaging and storage. Butter oil/Ghee. Ice cream: Definition, Classification and Composition, Constituents and their role. Preparation of mixes and freezing of Ice cream, Overrun, Judging, Grading, and defects of Ice cream.

Unit – IV

Evaporated and Condensed milk: Method of manufacture, Packaging and storage. Defects, Causes, and prevention. Roller and Spray Drying of milk solids. Instantization. Flow ability, Dustiness, Reconstituability, Dispersability, Wettability, Sinkability and appearance of milk powders. Manufacture of Casein, Whey protein, Lactose from milk or use in formulated foods and FSSAI Stndards.

Unit – V

Dairy Products Manufacturing: Process Technology and standards of manufacturing of malted milk drinks, Infant Foods, Fermented Milk and Other Milk Products (Casein, Whey Proteins, Lactose

Etc.). Indigenous dairy products manufacturing.Plant based milk: Almond,soy milk and Oat Milk. The role of plant-based proteins drink in human nutrition.Contaminant and Adulterants in Milk and Dairy Products.

Textbooks

1. Dairy Science and Technology" by P. Walstra, W. H. Schmidt, and J. T. M. Wouters.
2. Fundamentals of Dairy Chemistry" by H. Douglas Goff, W. L. H. S. Corbitt, and John A. McMahon
3. "Technology of Dairy Products" by R. K. Robinson

Reference Books

1. "Milk and Milk Products" by S. K. Puri, A. P. S. Kadian
2. "Dairy Processing: Improving Quality" by P. F. Fox, P. L. H. McSweeney
3. "Milk Processing and Quality Management" by A. R. N. G. R. Subramanian
4. Dairy Science & Technology (Springer)

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R23 IIIRD YEAR SYLLABUS

III Year -I Semester	**FOOD PACKAGING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course objective

- To learn about the importance of packaging used in food applications.
- To develop appropriate packaging techniques for storing of foods

Course outcomes

COs	**Statement**	**Bloom Level**
CO1	Able to select the different packaging materials based on properties	L2
CO2	Able to understand the suitability for different foods	L2
CO3	Understand the technology of manufacturing of plastic and glass	L3
CO4	Understands the innovative packaging techniques	L4
CO5	Understands the green plastics	L3

Unit – I Introduction: Importance and Functions of Food Packaging, Type of packaging materials; Selection of packaging material for different foods, Selective properties of packaging film; Tests on packaging materials - Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates; Methods of packaging and packaging equipment.

Unit – II Packaging materials and forms: Food grade polymeric packaging materials, Rigid plastic packages. Films: Oriented, Co-extruded, Laminates and Metallized; Glass: Composition, Properties, Bottle making and Closures for glass containers. Metal: Bulk containers, Tin-plate containers, Tin free steel containers, Aluminium containers, Corrosion and toxicity of packaging material.

Unit – III.

Modified Atmosphere Packaging (MAP): Principles, gases used in MAP and methods for creating MA conditions, factors affecting MAP and design of MAP. Modified Atmosphere Packaging (MAP) for fresh cut produce. Controlled atmosphere storage (CAS).Retort packaging foods, pillow pouch packaging, shrink wrapping packaging, aseptic packaging of foods

Unit – IV

National and international standards for food packaging: Bureau of Indian Standards (BIS).Food Safety and Standards Authority of India (FSSAI).FDA (US), EFSA (EU).ISO standards for packaging. Environmental considerations and regulations: Recycling, EPR (Extended Producer Responsibility), and circular economy..

Unit – V

Edible and Biodegradable packaging, antimicrobial food packaging – Introduction, antimicrobial agents and factors affecting its effectiveness. Non-Migratory Bioactive Polymers (NMBP) in food packaging: Introduction, advantages, and limitations. Microplastics in the Food Chain, Pathways of microplastic entry into the food chain, Mechanisms of leaching: Temperature, pH, and contact time. Impact of leached compounds on food safety: Bisphenol A (BPA), phthalates, and other chemicals.

Textbooks

1. Soroka, W.*Fundamentals of Packaging Technology*5th Edition (2020)
2. Robertson, G. L.*Food Packaging: Principles and Practice*3rd Edition (2016)
3. Singh, R. P., & Heldman, D. R.*Introduction to Food Engineering* (for basics of packaging interaction with food) 5th Edition (2013)
4. Han, J. H. (Editor)*Innovations in Food Packaging*2nd Edition (2013)

References

1. Galloway, T. S., & Lewis, C. N. *Marine microplastics and human healt*h
2. EFSA Panel on Contaminants in the Food Chain (CONTAM).
3 Coles, R., McDowell, D., & Kirwan, M. J. (Editors)*Food Packaging Technology*2nd Edition (2011)
4 FSSAI Guidelines for Food Packaging and Labeling.
5 Relevant ISO and BIS standards for food packaging.

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R23 IIIRD YEAR SYLLABUS

III Year -I Semester	PROCESSING OF MILK AND MILK PRODUCTS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

- To familiarize students with different practical processes involved in milk in processing
- To impart knowledge on quality testing of milk and products

Course Outcomes

COs	Statement	Bloom Level
CO1	Controls the shelf life limiting factors of milk	L2
CO2	Develops coagulated products from milk	L2
CO3	Development of traditional products	L2
CO4	Understands the source of adulteration	L4
CO5	Able to know the physico-chemical properties of milk and products	L4

1. Process technology of butter and ghee
2. Process technology of channa and paneer
3. Process technology of khoa and kalakhand
4. Process technology of flvoroed milk
5. Process technology of Ice cream
6. Determination of selected quality parameters of selected dairy products
7. Visit dairy plant and enumeration of different commercial dairy products
8. Microbial examination of milk
9. Microbial examination of milk products
10. Detection of Adulterants in Milk
11. Determination of Total Solids (Gravimetric method)
12. Determination of Fat in Cream
13. Determination of Total Solids in the Ice cream
14. Determination of Moisture in Channa/Paneer

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R23 IIIRD YEAR SYLLABUS

III Year -I Semester	**FOOD PACKAGING**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Course Objectives

- To acquire the skills on quality of packaging materials
- Evaluate the migration characteristics of packaging materials.
- Develop suitable packaging methods for food products.

Course Outcomes

COs	**Statement**	**Bloom Level**
CO1	Able to food packaging materials and their properties	L2
CO2	Explain and interpret various tests used in evaluating quality and safety of food packaging materials against invading pathogens	L2
CO3	Able to control Comprehend food and packaging material interactions	L2
CO4	Able to measure the barrier properties of packaging material	L3
CO5	Able to extend the shelf life of product through packaging film	L3

1. GSM measurement of a packaging material
2. To determine the grammage of packaging material
3. Calculation of moisture in packaging material using moisture meter
4. To evaluate the strength of corrugated boxes by crush tester
5. Vibration testing of different packages
6. Coating of packaging material for using automatic film applicator
7. Drop test of packaging material
8. Bursting strength of packaging material
9. Heat sealing of packaging material
10. Compression testing for packaging material
11. Universal testing machine for packaging material
12. Dart impact testing of packaging material
13. Seal strength of the packaging material
14. Leak proof detector of packaged food
15. Crock meter-digital motorized of the packaged film

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -I Semester	FERMENTATION TECHNOLOGY	L	T	P	C
		0	1	2	2

OBJECTIVE

- To acquaint with importance of food fermentation and its application.
- To acquaint with value addition through fermentation in foods

Course Outcomes

COs	Statement	Bloom Level
CO1	Describes the fermentation and its types.	L2
CO2	Understand the kinetic of Enzymes	L2
CO3	Understand the downstream process	L2
CO4	Able to operate the fermenter	L3
CO5	Produce different value added products	L3

UNIT-I Industrial Fermentation: Fundamentals involved in the production of industrial Microbial products such as details of the fermenters/Bioreactors, types of fermenters, Types of fermentation – solid state and submerged; Design and working of batch, fed-batch and continuous fermenters; Scale up of Bioreactors; Sterilization methods.Principles of fermentation: Traditional vs. precision fermentation.Applications of precision fermentation: Enzymes, dairy proteins (casein, whey), and functional ingredients.

UNIT-II Media for Fermentation: Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; importance of pH, temperature and aeration in fermentation; optimization of fermentation media. **Enzyme kinetics:** Michaelis-Menten Constant, Competitive, Non-competitive inhibitions, Lineweaver- Burke Plot, Regulation of enzymes. Growth Kinetics: Modeling and optimization techniques.

UNIT-III Downstream processing: Importance, need for downstream processing, unit operations for downstream processing (Cell Harvesting and Disruption, Filtration, Centrifugation, Extraction, Adsorption, Chromatography, Electrophoresis, Membrane separation & Drying) and their importance.

UNIT-IV Alcoholic Beverages : Production of Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka etc.), sugar cane (rum) etc. Process description, quality of raw materials, fermentation process controls etc.Regulations for Alcoholic Beverages;FSSAI, US FDA and European Union (EU).

UNIT-V . **Non-Alcoholic Beverages:** Production of non-alcoholic beverages like tea, coffee and cocoa. A detailed study of 'Ethanol' production by fermentation using black strap molasses, starchy substances and cellulose substrates like waste sulphate liquor and purification methods for production of absolute ethyl alcohol.Regulations for Non-Alcoholic Beverages: FSSAI (India): Standards for water-based, fruit-based, and dairy-based beverages.Codex Alimentarius.US FDA and European Union (EU) regulations for non-alcoholic beverages.

Textbook

1. Zhang, J., & Wen, T.*Fermentation Microbiology and Biotechnology* (4th Edition, 2021).
2. Nicolini, C., & Knecht, W.*Synthetic Biology and Precision Fermentation for Food and Beverage Applications* (2020).
3. Archer, D., & Tubb, C.*The Future of Alternative Proteins* (2021).

References:

1. Yang, S. T., El-Enshasy, H. A., & Thongchul, N.*Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals, and Polymers*1st Edition (2019)
2. Pandey, A., Larroche, C., Soccol, C. R., & Dussap, C. G.*Advances in Fermentation Technology*1st Edition (2021)
3. Wang, D. I. C., Cooney, C. L., Demain, A. L., Dunnill, P., Humphrey, A. E., & Lilly, M. D.*Fermentation and Enzyme Technology*Reprint (2013)
4. Crueger, W., & Crueger, A. - *Biotechnology: A Textbook of Industrial Microbiology* (3rd Edition, 2004).

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -I Semester	GRAIN STORAGE TECHNOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVE

- to provide students with a comprehensive understanding of technological approaches, and management practices required.
- to ensure the safe, efficient, and sustainable storage of grains and related agricultural products.

Course Outcomes

COs	Statement	Bloom Level
CO1	Understand Grain Characteristics	L2
CO2	Master Storage Techniques	L2
CO3	Pest and Spoilage Management	L2
CO4	Minimize Post-Harvest Losses	L3
CO5	Ensure Food Safety and Quality	L3

Unit 1: Introduction to Grain Storage

Grain Characteristics: Physical, chemical, and biological properties of grains affecting storage. Moisture Content: Role of equilibrium moisture content (EMC) and safe moisture levels for storage. Post-Harvest Losses: Causes, types (qualitative and quantitative), and prevention strategies. Storage Requirements: Environmental factors (temperature, humidity, aeration) and their impact on grain quality.

Unit 2: Storage Structures and Systems

Traditional Storage Systems: Bins, pits, and other indigenous methods. Modern Storage Systems: Silos (vertical and horizontal), warehouses, and cold storage for grains. Design of Storage Structures: Ventilation, pest control, and handling equipment. Storage Economics: Cost analysis, energy requirements, and optimization techniques. FCI Storage Practices; Scientific storage practices adopted by FCI, Challenges and advancements in FCI storage systems.Types of hermetic storage solutions: bags, containers, and silos, Purdue Improved Crop Storage (PICS) bags, GrainPro bags, and Cocoon storage.

Unit 3: Grain Deterioration and Pest Management

Biological Factors: Molds, insects, and rodents; effects on grain quality and safety. Chemical Deterioration: Lipid oxidation, enzymatic changes, and toxin formation. Integrated Pest Management (IPM): Principles and practices in stored grains. Fumigation Techniques: Chemicals used, safety protocols, and alternatives like hermetic storage.

Unit 4: Drying and Aeration Technology

Grain Drying Principles: Psychrometry, drying curves, and factors affecting drying. Drying Methods: Batch, continuous flow, solar, and mechanical dryers. Aeration Techniques: Principles, equipment, and optimization. Energy Efficiency in Drying and Aeration: Emerging trends and sustainability.

Unit 5: Quality Control and Regulatory Standards

Grain Quality Assessment: Physical, chemical, and microbiological evaluation. Storage Standards: National and international standards for grain storage and handling. Packaging for Storage: Materials, techniques, and innovations in grain packaging. Case Studies: Successful grain storage systems and practices worldwide.

Reference Textbooks

1. Chakraverty, A., "Post-Harvest Technology of Cereals, Pulses, and Oilseeds" (Revised Edition). Oxford and IBH Publishing Co. Pvt. Ltd.
2. Desrosier, N.W. & Desrosier, J.N., "The Technology of Food Preservation". CBS Publishers & Distributors.
3. Hall, C.W., "Drying and Storage of Agricultural Crops". AVI Publishing Co.
4. Agrawal, R.L., "Seed Technology". Oxford and IBH Publishing Co. Pvt. Ltd.
5. Hodges, R.J. & Farrell, G., "Grain Storage Techniques: Evolution and Trends in Developing Countries". Food and Agriculture Organization (FAO).

III Year -I Semester	FOOD BIOTECHNOLOGY	L	T	P	C
		2	0	0	2

OBJECTIVE

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Course Outcomes

COs	Statement	Bloom Level
CO1	Describe the principles of biotechnology and their application in food processing and preservation.	L2
CO2	Analyze fermentation processes and develop strategies for producing fermented foods and probiotics.	L2
CO3	Evaluate the safety, quality, and regulatory aspects of biotechnology-derived foods.	L2
CO4	: Develop biotechnological methods for producing nutraceuticals, bio-preservatives, and value-added food products.	L3
CO5	Explore cutting-edge technologies and their potential applications in sustainable food innovation.	L3

Unit 1: Introduction to Food Biotechnology

Biotechnology Basics: Definition, scope, and applications in the food industry. Microorganisms in Food: Role of bacteria, yeast, and fungi in food processing and preservation. Genetic Engineering: Basics of recombinant DNA technology and its applications in food. Enzymes in Food Biotechnology: Sources, production, and industrial applications.

Unit 2: Fermentation Technology

Fermentation Principles: Types, processes, and factors affecting fermentation .Fermented Foods: Production of dairy, bakery, and alcoholic products. Fermenters: Design, operation, and scale-up of bioreactors. Emerging Trends: Probiotics, prebiotics, and synbiotics.

Unit 3: Food Safety and Quality Control

Food Safety Issues: GMOs, allergens, and ethical concerns in biotechnology. Biopreservation: Role of bacteriocins, organic acids, and other bio-preservatives.Detection Methods: iosensors and rapid microbial testing techniques. Regulatory Frameworks: National and international regulations for biotechnology-derived foods.

Unit 4: Production of Value-Added Products

Bioprocessing of Food Waste: Bioethanol, bioplastics, and other value-added roducts. Nutraceuticals: Biotechnology in the production of functional foods and health supplements. Flavor and Color Enhancers: Microbial production of food additives and sensory enhancers. Case Studies: Successful food biotechnology projects and products.

Unit 5: Advances in Food Biotechnology

Omics in Food Biotechnology: Genomics, proteomics, and metabolomics for food innovation.CRISPR Technology: Applications in food science for genome editing, Overview of metagenomics and its significance, Tools for metagenomic data analysis (QIIME, MEGAN, Metaphlan, etc.).Edible Vaccines: Development and challenges in producing plant-based vaccines.Future Trends: Artificial meat, biofortification, and sustainable bioprocesses.

Reference Textbooks

1. Baines, D. & Seal, R., "Natural Food Additives, Ingredients and Flavourings". Woodhead Publishing.
2. Joshi, V.K. & Pandey, A., "Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology". Volumes 1 & 2. Educational Publishers & Distributors.
3. Shetty, K., Paliyath, G., & Pometto, A., "Food Biotechnology". CRC Press.
4. Campbell-Platt, G., "Food Science and Technology". Wiley-Blackwell.
5. Stanbury, P.F., Whitaker, A., & Hall, S.J., "Principles of Fermentation Technology". Elsevier Science.

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -II Semester	FOOD TOXICOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the fundamental principles of toxicology and their application to food safety.
2. To identify and analyze the sources and effects of natural, environmental, and processing-induced toxicants in food.
3. To evaluate the safety of food additives and packaging materials through toxicological testing methods.
4. To gain knowledge of risk assessment processes and regulatory frameworks for ensuring food safety.
5. To explore advanced analytical techniques and study historical and emerging issues in food toxicology.

Course Outcome:

COs	Statement	Bloom Level
CO1	Explain the basic principles of toxicology and identify sources of toxicants in food.	L2
CO2	Analyze the effects of natural and environmental toxicants on human health and food safety.	L3
CO3	Evaluate the safety of food additives and identify risks associated with processing-induced toxicants.	L3
CO4	Apply risk assessment principles and understand regulatory standards for food safety.	L4
CO5	Utilize advanced detection techniques and critically analyze case studies to address food safety challenges.	L3

Unit I: Introduction to Food Toxicology

Basics of Toxicology: Definition, scope, and importance in food safety.Toxicity Types: Acute, chronic, sub-chronic, and cumulative toxicity.Dose-Response Relationship: Threshold levels, LD50, and NOAEL concepts.Sources of Food Toxicants: Natural, environmental, and industrial contaminants and residues.

Unit II: Natural and Environmental Toxicants

Naturally Occurring Toxicants: Plant toxins (alkaloids, glycosides, mycotoxins) and marine toxins.Anti-Nutritional Factors: Oxalates, tannins, lectins, and their effects.Environmental Contaminants: Pesticides, heavy metals, and industrial pollutants. Biodegradation of Toxins: Microbial and enzymatic approaches.

Unit III: Food Additives and Processing-Induced Toxicants

Food Additives: Toxicological evaluation of preservatives, colorants, and flavor enhancers. Processing-Induced Toxicants: Acrylamide, polycyclic aromatic hydrocarbons (PAHs), and nitrosamines**.** Contaminants in Food Fats and Oils;Acrylamides: Formation during food processing (e.g., frying, baking), Furans and their derivatives: Types of furans (e.g., 2-acetyl furan, deoxy furan).

Unit IV: Risk Assessment and Regulatory Framework

Risk Assessment Steps: Hazard identification, exposure assessment, and risk characterization. Toxicity Testing Methods: In vitro, in vivo, and alternative models. Regulations and Standards: National and international regulatory frameworks (FSSAI, Codex Alimentarius, EFSA).Consumer Awareness: Educating the public about food safety.

Unit V: Advances and Case Studies in Food Toxicology

Emerging Concerns: Nanotoxicology, endocrine disruptors, and food allergens. Analytical Techniques: LC-MS, GC-MS, and other advanced methods for detecting toxicants. Food Toxicology Case Studies: Historical incidents like mercury poisoning and melamine contamination. Future Directions: Research trends and technologies in toxicology.

Reference Textbooks

1. Shibamoto, T. & Bjeldanes, L.F., “Introduction to Food Toxicology”. Elsevier Science.
2. Duffus, J.H. & Worth, H.G.J., “Fundamental Toxicology for Chemists”. Royal Society of Chemistry.
3. Watson, D.H., “Natural Toxicants in Food”. CRC Press.
4. Hayes, A.W., “Principles and Methods of Toxicology”. CRC Press.
5. Fennema, O.R., “Food Chemistry”. CRC Press (Chapters on toxicants).

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R23 IIIRD YEAR SYLLABUS

III Year -II Semester	PROCESSING OF MEAT, POULTRY, FISH AND MARINE PRODUCTS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand about the composition, nutritive value of meat, and marine products
- To know about processing technology of meat and fish
- To learn the value addition and packaging of meat, and marine products

Course Outcome:

COs	Statement	Bloom Level
CO1	Able to handle the slaughter methods	L2
CO2	Understand the principles of preservation	L3
CO3	Able to cut and handle the product	L3
CO4	Develops canned meat and fish	L4
CO5	Able to know the source of contamination to maintain quality	L3

Unit 1: **Introduction to Meat and Poultry Processing**

Composition and Structure: Muscle structure, composition of meat. Chemical and nutritional properties. Slaughtering and Dressing: Techniques and principles of animal and poultry slaughter. Inspection, grading, and humane practices. Postmortem Changes: Rigor mortis, aging, and quality changes. Factors influencing meat quality.

Unit 2: Meat Processing and Preservation Methods:

Chilling, freezing, curing, and smoking. Packaging requirements for fresh and processed meats. **Processed Meat Products**: Sausages, ham, bacon, and other value-added products. Additives and their roles (binders, emulsifiers, and flavor enhancers). **Quality and Safety**: Microbial hazards, hygiene practices, and HACCP in meat processing.

Unit 3: Fish and Marine Products Processing Characteristics of Fish: Composition, spoilage mechanisms, and post-harvest changes. Processing Techniques: Chilling, freezing, canning, and drying. Value-added products: fish fillets, surimi, fish protein concentrates. Marine Products: Processing of shrimp, crab, and mollusks. Seaweed and algae processing

Unit 4 Introduction to Cutting methods; Principles of meat cutting: anatomy, muscle structure, and alignment, Tools, Equipment and Safety and Hygiene in Cutting. Types of Meat Cuts – Beef, Pork, Lamb and Polutry. Specialized Cuts and Global Practices**.**

Unit – VBy-Products from Meat, poultry, and marine processing:Chitin and Chitosan: Derived from shrimp and crab shells for biomedical and industrial use. Fish Protein Hydrolysates: .Fish Meal and Silage: Use Silage: eggs and their utilization; Safety standards in meat industry: HACCP/ISO/MFPO/FSSAI/Kosher/Halal .Introduction to cell-based meat

Textbooks

1. G.C. Mead"*Poultry Meat Processing and Quality*" (2nd Edition, 2020)
2. Daneysa L. Kalschne, Marinês P. Corso, Cristiane Canan"*Advances in Meat Processing Technologies*" (2020).
3. Meat, Egg and Poultry Science & Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.

References

1. "Meat Science" by P.D. Warriss
2. "Lawrie's Meat Science" (8th Edition) by Fidel Toldrá
3. "Handbook of Meat Processing" by Fidel Toldrá
4. "Poultry Meat Processing and Quality" (2nd Edition) edited by G.C. Mead
5. "Food Processing Technology: Principles and Practice" (4th Edition) by P.J. Fellows
6. "Advances in Meat, Poultry and Seafood Packaging" by Joseph Kerry

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -II Semester	UNIT OPERATION IN FOOD ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- Gaining knowledge of equipment used in food processing plant.
- Fundamentals of principle of various unit operations

Course Outcome:

COs	Statement	Bloom Level
CO1	Ability to apply various unit operation in Food industry	L2
CO2	Able to select appropriate equipment for different foods	L3
CO3	Able to analyze the unit operation	L3
CO4	Capable to troubleshoot and optimize unit operation	L5
CO5	Able to cope up with advancement in food engineering	L6

Unit – I Geometrical, physical, functional and growth property of foods. Cleaning, sorting and grading of foods. Peeling, decortication, deseeding of fruits, dehulling of grains, blanching of vegetables. **Size Reduction**: Principles and types of size reduction equipment, disintegration of fibrous materials. Principles of comminution, Types of comminuting equipment. Energy and power requirement, Crushers, Grinders, Mechanical expeller.

Unit – II Filtration: Principle of Constant pressure and constant rate filtration and types of filtration equipment, Settling classifiers and Flotation Screening, types of screen. **Centrifugation:** Principle of settling and centrifugation, devices for centrifugal separation. Membrane separation processes: Reverse osmosis, nano-filtration, ultrafiltration, microfiltration, dialysis and pervaporation.

Unit – III Mixing: Mixing of liquids and solids (powder), mixing equipment, mixing index and mixing time, Agitation and blending, types of agitators, power consumption in mixing. Scope and importance of material handling devices; Study of different material handling systems: Classification, principles of operation.

Unit – IV Conveying systems: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Unit – V

Measurement & Control of Process Parameters: Various Process Parameters, On-line & Off-line parameters, Critical & non-critical parameters, Measurement of various parameters, controlling methods (Manual, Automatic & Computer control).**Introduction to 3D Food Printing**: Overview of the technology, history, and applications in food design and manufacturing. Types of 3D Food Printers

Text Books

1. R.K. Rajput. 2017. Engineering Thermodynamics, 3rd Ed. Laxmi Publications (P) Ltd., Bangalore.
2. P.G. Smith, Introduction to Food Process Engineering, 2nd Edition, Lincoln, UK, 2010

References:

1. J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
2. R. Paul Singh and Dennis R. Heldman, Introduction to Food Engineering, 4th Edition, Academic Press, 2009.
3. Z. Berk, Food Process Engineering and Technology, Food Science and Technology, 1st Edition, International Series, Elsevier, 2009.
4. D. G. Rao, Fundamentals of food engineering, Prentice-Hall of India, New Delhi, 2010

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -II Semester	FOOD QUALITY, SAFETY STANDARDS AND CERTIFICATION	L	T	P	C
		3	0	0	3

Course Objective:

- Understand the importance of food safety.
- Basic knowledge on Standards and certification bodies.

Course Outcome:

COs	Statement	Bloom Level
CO1	Able to implement the quality indices in food industry	L2
CO2	Asses the quality through various techniques	L2
CO3	Able to avoid the contamination in the process	L3
CO4	Able to follow FSSAI standards in food processing	L4
CO5	Become as a certified person in food industry	L5

Unit – I

Quality and Assurance: Definition, scope, importance and difference, Total quality control and (TQC) Total quality management (TQM), Statistical quality control. Definition, importance, scope and difference between food quality and food safety. Food quality and quality attributes - Classification of quality attributes and their role in food quality, objectives, importance and functions of quality control, principles of quality assurance.

Unit – II

History of food adulteration and evolution of standards. **FSSAI:** Food Safety and Standards Act-2006: Scope; Definitions; Food Safety Standards Rules, Food Safety Standards Regulations, Food Safety & Standards Authority of India– Organizational chart.Food Laws and Regulations, FSSAI Initiatives - Eat Right, RUCO, Aligning With SDGs, Nutrition And Health.

Unit – III- Codex Alimentarius: Origin & meaning, Membership, Role of CAC and its committees, Codex Alimentarius – PRP – GMP – GHP – GAP-GLP - GRAS- SSOP, Temperature control.

Unit – IV

Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. HACCP, VACCP, TACCP, Food Fraud, Allergens, Preventive Controls, One Health, AMR, - principles – Hazard analysis – determine CCP – establish critical limit.. Introduction to JEMRA and JECFA

Unit – V

ISO-Origin, Members, Governance, Committees, Procedure employed in development and issue of standards. ISO/TC 34, ISO 9000 series, ISO 22000Comparison of ISO 9001,ISO 22000, ISO 17025,17034 and ISO 17043.

Textbooks

1. Food safety and standards regulations, 2017.

2. General requirements (Food Hygiene) of the Codex Alimentarius, Volume II. Food and Agriculture organization of the United Nations.

References

1. The ministry of health and family welfare, The Gazette of India: Extraordinary, Part- III, section

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R23 IIIRD YEAR SYLLABUS

III Year -II Semester	PROCESSING OF MEAT, POULTRY, FISH AND MARINE PRODUCTS LAB	L	T	P	C
		0	0	2	1

Course Objective:

- Skill development to handle meat, poultry, and marine products.

Course Outcome

COs	Statement	Bloom Level
CO1	Able to develop different meat products	L3
CO2	Able to assess the meat quality	L3
CO3	Able to implement safe practice	L3
CO4	Able to standardize the formulation for meat products	L4
CO5	Able to get knowledge through industrial visit	L3

1. Pre-slaughter operations of meat animals and poultry birds
2. Slaughtering and dressing of meat animals
3. Study of post-mortem changes; Meat cutting and handling
4. Preservation of meat by curing and pickling
5. Evaluation of quality and grading of eggs
6. Preparation of value-added poultry meat products
7. Value added egg products
8. Study of anatomy and dressing of fish
9. Study of anatomy and dressing of prawn and other marine products
10. Identification of different types of fish - Selection and grading
11. Identification of different types of prawn and other marine products - Selection and grading

Quality evaluation of fish

12. Preparation of sun dried and salt cured fish, fish sauce
13. Chilling and freezing of fish
14. Preservation of fish: Drying, pickling
15. Preparation of value added sea products: Cutlets, bullets, wafers
16. Preparation of marine algal products
17. Utilization of fish by-products
18. Visit to Abattoir
19. Visit to fish and prawn processing industry.

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R23 IIIRD YEAR SYLLABUS

III Year -II Semester	UNIT OPERATION IN FOOD ENGINEERING LAB	L	T	P	C
		0	0	2	1

Course Objective:

- Acquire knowledge of equipment in food processing
- Understand the principles of equipment operation and process control.

Course Outcome:

COs	Statement	Bloom Level
CO1	Able to analyze the food process operation	L2
CO2	Able to handle the equipment's	L2
CO3	Capable to apply principle in unit operations	L3
CO4	Able to optimize the unit operation	L4
CO5	Able to stop break downs of the unit operation	L5

1. Determination of physical properties such as bulk density, porosity, sphericity, angle of repose etc
2. Particle size distribution using sieve shaker.
3. Size reduction using Ball Mill and calculation of critical speed of mill.
4. Size reduction using Rod mill and calculation of equivalent diameter of solid particle.
5. Size reduction using Hammer Mill and calculation of critical speed of mill.
6. Mixing experimentation and determination of uniformity coefficient in planetary mixer.
7. Study of mechanical expression of edible oil.
8. Mixing experimentation and determination of uniformity coefficient.
9. Determination of power consumption in mixing/agitation.
10. Filters and filter resistance.
11. Determine the terminal velocity of Cyclone separator.
12. Studies on membranes separation processes.
13. Mixing of powder by ribbon mixer and calculation of mixing index
14. Specific cake resistance using rotary drum vacuum filter press.

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

III Year -II Semester	FOOD PRODUCT DEVELOPMENT	L	T	P	C
		0	1	2	2

Course Objective:

- Skill development through food product development
- Understand the formulation and standardization methods.

Course Outcome:

COs	Statement	Bloom Level
CO1	Able to develop the product from fruits and vegetables	L3
CO2	Able to develop the product from Cereals	L3
CO3	Able to develop the product from Fish	L3
CO4	Able know the waste generation	L2
CO5	Able to develop by product	L4

Unit – I processed Fruits and Vegetables Products: Jam, Jelly, syrup, cordial, nectars and squash Dehydration of Fruits and Vegetables, Products; Dehydrated, Wafers and Papads, Soup powders; Food additives: Use in fruit and vegetable preservation; Restructured fruits & Vegetables

Unit – II Processed rice products (flaked, expanded and puffed rice). By-products. Wheat flour, Baked products- Ingredients Technology and quality parameters: Bread, Biscuits and Cakes, Cracker Basic malting process, malting plant, malt storage, malt characteristics, malt extract, uses; Breakfast cereals.

Unit-III Processing of Plantation crop and spices ;Coffee, Tea and Cocoa, Coconut, A recanut, Vanilla and Cashew nut– production and importance – harvesting and stages of harvest – drying, cleaning, and grading, processing methods, process and equipment – value added products – Processing of Spices and Extraction: Oleoresins and essential oils: Methods and applications. **Value-Added Products**: Spice blends, flavoured oils, and spice pastes.

Unit – IV Fish products: Introduction, fish muscle proteins, surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish minced products; Preparation protocols of indigenous products: Fish sauce and paste.

Unit – V Introduction to Industrial by - products and waste – facts and figures in India and world-Potentials and prospects of developing by-products Industry in India. Agricultural wastes and agro based industries - Types of By-products in agro - based industries - commercial compounds obtained from by-products.

Textbooks

1. A Chakraverty, Post-Harvest Technology of Cereals, Pulses and Oil Seeds. Oxford and IBH Publishing Co. Ltd., Calcutta
2. Giridharlal, Siddappa and GL Tandon, ICAR. Preservation of fruits and vegetables, New Delhi.
3. Sudheer Gupta (Compiled), EIRI Fruits & Vegetables Processing Handbook, Delhi.

4. R.P. Srivastava, Sanjeev Kumar, Fruit and vegetable preservation-3rd Edition, International Publishers, Delhi.
5. Norman N. Potter. Food Science.

References

1. Sukumar De, Outlines of Dairy Technology. Oxford University Press. New Delhi.
2. Ervan. Food from Wastes.
3. Sharma, B.D. Modern Abattoir Practices and Animal by Products Technology, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi
4. P. Chereminost. Food Protein sources - Fire Energy from Solid Waste
5. B.H. Webb and E.O.Whittier, By-Products from Milk - AVI Publishers Co., West port, Connecticut, USA.

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –II	L	T	P	C
		3	0	0	3

NON-THERMAL OPERATIONS IN FOOD PROCESSING

Course Objective:

- To introduce the concept of processing and preserving of foods without heating
- To make students familiar about different non thermal techniques and their applications in food processing industries

Course Outcome:

COs	Statement	Bloom Level
CO1	Able to Recall the principles of preservation	L2
CO2	Able to Interpret the various emerging non thermal techniques available for food processing	L4
CO3	Able to Apply the techniques for preservation of foods	L3
CO4	Able to Evaluate the suitability of the techniques for specific food	L3
CO5	Able to Gain knowledge on cold plasma and its food applications	L2

UNIT I

High-Pressure Processing (HPP); Principles of isostatic pressure and its effects on food. Equipment and process design. Applications in juice, dairy, and ready-to-eat food. Pressure driven filtration: Membrane technology – Microfiltration, Ultrafiltration, Nano filtration, Reverse osmosis, and Applications.

UNIT II

Hurdle Technology: Types of preservation techniques and their principles, the concept of hurdle technology and its applications. Irradiation in food products, principles and applications. Ozone processing in foods.

UNIT III

High Pressure Processing & Ultrasound Processing: HPP -Types of equipment, mechanism of microbial inactivation, effect of HPP on fruit juices, meat products and etc. Ultrasonic processing - Properties of ultrasonic, types of equipment, the effect of ultrasonic treatment on microbial inactivation, oil yield.

UNIT IV

Pulse Light Technology: High-intensity pulse technique - Processing systems, design of static chambers, continuous chambers, other chamber designs, generation of different voltage waveforms. Oscillation magnetic fields for food processing, generation of magnetic fields, mechanisms of inactivation of microorganisms in food preservation. Application of high-intensity light in food processing. Pulse electric field-mechanism of inactivation, PEF generation system, PEF treatment.

UNIT V

Recent Non-Thermal Methods: Cold Plasma - Principle of cold plasma technology and its generation systems and its application. Cryogenic grinding - Properties of cryogens, systems, and their different applications.

Textbooks

1. Chauhan, O. P. (Ed.). (2019). *Non-thermal processing of foods*. CRCPress.

2. Brennan, J. G., & Grandison, A. S. (Eds.). (2012).Wiley - VCH.
3. Sahu, J. K. (Ed.). (2014). *Introduction to advanced food process engineering*. CRC Press.

References

1. Barbosa-Cánovas, G. V., Tapia, M. S., & Cano, M. P. (Eds.). (2004). *Novel food processing technologies*. CRCpress.
2. Gould, G. W. (Ed.). (1995). *New methods of food preservation*. Springer Science & Business Media.

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –II	L	T	P	C
		3	0	0	3
FOOD PROCESS EQUIPMENT DESIGN					

Course Objectives

- This imparts knowledge on the principles, mechanism, selection, and design of different pieces of equipment used in the food industry.
- To introduce students to a wide range of equipment such as heat exchangers, dryers, freezer, conveyors for different process operations, their design considerations, and material selection

COs	Statement	Bloom Level
CO1	Able to Gain insights on basic design considerations, process flow, costing involved in equipment design	L3
CO2	Able to Gain insights on design parameters, maintenance, and scale-up of those requirements	L3
CO3	Able to Apply the techniques in process models, construction and maintenance of dryers and evaporators	L3
CO4	Able to Gain knowledge on design, operation, and maintenance of cold storages	L3
CO5	Able to Gain knowledge on hygienic and safety design of food equipments	L2

Course Outcome:

UNIT I

Introduction: General introduction about different food equipments and processes. Process flow sheets, Material and energy balances, Computer-aided food process design. Basic and secondary design considerations, materials of construction, strength of construction, selection of equipment. Fabrication and installation of equipment. Sizing and costing of equipment. Numerical related to mass and energy balance

UNIT II

Design of Mixing, Size Reduction and Conveying Equipments: Design consideration of mixing and blending equipment, Design of agitators and scale-up, Operation and maintenance. Design consideration of size reduction equipment, installation and maintenance. Design consideration of material conveying equipment, belt conveyor, screw conveyor, bucket elevator, pneumatic conveyor. Numerical related to design aspects of mixing, size reduction, and conveying equipment.

UNIT III

Design of Heat Exchangers, Evaporators & Dryers: Design of heat exchangers, plate heat exchangers, shell and tube heat exchangers, design of finned type heat exchanger, materials of construction, installation and operation. Design of single effect evaporators, applications. Multiple effect evaporators, installation and maintenance. Design aspects and considerations for cabinet dryer, fluidized bed dryer, spray dryer, freeze dryer and foam mat dryer, Installation, Operation and Maintenance. Drying kinetics, drying models, drying time and drying rate prediction.

UNIT IV

Design of Cold Storages and Freezers: Design of cold storage, factors to be considered, estimation of cooling load, operation-construction, installation, and maintenance of cold storage. Design consideration for controlled atmospheric storage and modified atmospheric storage of perishables. Design of freezers, design considerations, construction, and operation. Design of frozen storage, installation, and operation. Freezing time calculations, methods of prediction, mathematical models and numerical.

UNIT V

Hygienic Design & Operational Safety of Food Processing Equipment: Introduction to hygienic design and safety measures. Hygienic standards and regulations, cleaning of food processing equipment. Good manufacturing practices, food safety program. GMP and HACCP. Testing of equipment. Design of Pressure and storage vessels. Design of sterilizing vats, pulpers, and crushers. Numerical related to the design of the above equipment.

Textbooks

1. Saravacos, G. D., & Kostaropoulos, A. E. (2002). *Handbook of food processing equipment* (Vol. 2012, pp. 331-381). KluwerAcademic/Plenum.
2. Maroulis, Z. B., & Saravacos, G. D. (2003). *Food process design*. CRCPress.

References

1. Heldman, D. R. (Ed.). (2012). *Food process engineering*. Springer Science & Business Media.
2. Hall, C. W. (1979). *Processing equipment for agricultural products* (No. 04; S698, H3 1979.). AVI Publications
3. Clark, J. P. (2005). *Food plant design*. Food Eng, *4*,683-696. Encyclopedia of Life Support Systems

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –II	L	T	P	C
		3	0	0	3
NOVEL TECHNOLOGIES IN FOOD PROCESSING					

Course Objectives

- Identify and understand the latest advancements in food processing technologies, including non-thermal methods, advanced packaging, and automation.
- Analyze how these technologies are applied to enhance food quality, safety, shelf life, and nutritional value while maintaining sustainability.

Course Outcome:

Unit 1: Introduction to Novel Technologies

COs	Statement	Bloom Level
CO1	To explore non-thermal and innovative thermal techniques for enhancing food quality and shelf life.	L3
CO2	To understand the role of nanotechnology, encapsulation, and smart packaging in the food industry.	L3
CO3	To evaluate the environmental and economic aspects of novel food engineering technologies.	L3
CO4	To analyze the emerging trends and future potential of innovative technologies in sustainable food productio	L3
CO5	To explore non-thermal and innovative thermal techniques for enhancing food quality and shelf life.	L2

Overview of Novel Technologies: Importance, scope, and applications in food engineering.Drivers for Innovation: Consumer demand, regulatory requirements, and sustainability concerns.Emerging Food Processing Needs: Quality enhancement, waste reduction, and value addition.

Unit 2: Non-Thermal Processing Technologies

High-Pressure Processing (HPP): Principles, equipment, and applications.Pulsed Electric Fields (PEF): Mechanism, process parameters, and uses.Ultrasound Processing: Applications in emulsification, extraction, and microbial control.Cold Plasma Technology: Fundamentals and applications in food sterilization and packaging.

Unit 3: Innovative Thermal Processing Technologies

Ohmic Heating: Principles, applications, and advantages.Microwave and Radio Frequency Heating: Mechanisms, process design, and food applications.Infrared Heating: Principles and applications in drying and baking.Emerging Combination Techniques: Integration of thermal and non-thermal methods for improved processing.

Unit 4: Nanotechnology and Encapsulation

Nanotechnology in Food: Nano emulsions, nanopackaging, and nano sensors.Encapsulation Techniques: Spray drying, freeze-drying, and coacervation for flavor, nutrient, and bioactive delivery. Food Safety and Nano-regulations: Potential risks and ethical concerns.

Unit 5: Smart Packaging and Sustainability

Smart and Active Packaging: Role of intelligent packaging in improving shelf life and traceability.Edible Packaging: Materials, production, and applications in food sustainability.Techno-Economic Feasibility Analysis and Life Cycle Assessment (LCA): Environmental impact and cost analysis of noveltechnologies.Future Trends: Automation, robotics, and IoT in food processing and packaging.

Reference Textbooks

1. Zhao, Y.H. & Pierce, K., "Innovative Food Processing Technologies". CRC Press.
2. Knoerzer, K., Buckow, R., & Versteeg, C., "Innovative Food Processing Technologies: Advances in Multiphysics Simulation". Wiley.
3. Rastogi, N.K., "Emerging Technologies for Food Processing". Elsevier.
4. Heldman, D.R. & Lund, D.B., "Handbook of Food Engineering". CRC Press.
5. Norton, T. & Sun, D.W., "Emerging Technologies for the Food Industry". Academic Press.

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R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –III	L	T	P	C
		3	0	0	3
BEVERAGE TECHNOLOGY					

Course Objectives

- To study about the manufacturing steps of carbonated and non-carbonatedbeverages
- To study the hygiene conditions of beverages and its standards in foodssafety

Course Outcomes

COs	Statement	Bloom Level
CO1	To understand the process of carbonated and non-carbonated beverages	L3
CO2	To learning about the importance of hygiene and standards in food industries	L3
CO3	Acquire knowledge on the sanitation of the beverage equipment and quality control	L3
CO4	Understanding the standards of beverages and water specifications	L3
CO5	Understanding the packaging methods for storing of non-carbonated beverages.	L2

UNIT I

Beverage-definition-ingredients- water, carbon dioxide, bulk and intense sweeteners, water miscible and water dispersible flavoring agents, colors–natural and artificial, Micro and nano emulsions of flavors and colors in beverages, preservatives, emulsifiers and stabilizers.

UNIT II

Technology for Alcoholic Beverages: Raw materials Malt, hops, adjuncts, water, yeast quality and handling. Beer manufacturing process malting, preparation of sweet wort, brewing, fermentation, pasteurization and packaging. Beer defects and Spoilage. Wine-fermentation-types–red and white. Wine defects and spoilage. Equipment and machinery for Wine, Beer, Whiskey, Brandy, and Rum. Cereal Fermentation. Packaging and storage of different beverages.

UNIT III

Equipment and machinery for carbonated beverages, water treatment, syrup preparation, filling system, packaging containers and closures, handling of empty containers and cleaning, carbonation, filling, inspection and quality control.

UNIT IV

Technology for Non-carbonated Beverages: Raw materials quality and handling. Coffee bean preparation-processing-brewing-decaffeination- instant coffee-tea types-black, green and oolong-fruit juices, nectars, squash, RTS beverages, isotonic Beverages. Flash pasteurization, canning and aseptic Packaging of beverages. Equipment and machinery used.

UNIT V

Effective application of quality controls-sanitation and hygiene in beverage industry-quality of

water used in beverages-threshold limits of various ingredients according to FSSAI, EFSA and FDA- Introduction to Neutraceuticals, Functional Beverages, Bioactive Compounds in Neutraceuticals and Functional Beverages.

Textbooks

1. Ashurst, P. R. (2016). *Chemistry and technology of soft drinks and fruit juices*. John Wiley & Sons.
2. Steen, D., & Ashurst, P. R. (Eds.). (2008). *Carbonated soft drinks: formulation and manufacture*. John Wiley &Sons.
3. Manay, N. S. O. (2001). *Food: facts and principles*. New Age International.
4. Hui, Y. H., Meunier-Goddik, L., Josephsen, J., Nip, W. K., & Stanfield, P. S. (Eds.). (2004).*Handbook of food and beverage fermentation technology*(Vol.134).CRCPress.

References

1. Chakraverty, A., Mujumdar, A. S., & Ramaswamy, H. S. (Eds.). (2003). *Handbook of postharvest technology: cereals, fruits, vegetables, tea, and spices*(Vol.93).CRCpress.
2. Hutkins, R.W.(2008).*Microbiologyandtechnologyoffermentedfoods*.JohnWiley&Sons.Boulton,C., &Quain, D.(2008). *Brewing yeast and fermentation*.JohnWiley&Sons

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R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –III	L	T	P	C
		3	0	0	3
BREWING TECHNOLOGY					

Course Objectives

- To enable the student to understand basics of malting and brewing.
- To enable the student to understand different methods of beer production Course Outcomes

Course Outcomes

UNIT I

COs	Statement	Bloom Level
CO1	Describe the history, raw materials, and basic principles of brewing processes, including malting, mashing, and fermentation.	L3
CO2	Analyze the stages of brewing, including wort production, fermentation, and post-fermentation processes, and explain their role in beer quality.	L3
CO3	Acquire knowledge on the sanitation of the beverage equipment and quality control	L3
CO4	Assess the physical, chemical, and sensory attributes of beer using standard analytical and sensory evaluation techniques.	L3
CO5	Demonstrate awareness of modern brewing technologies, sustainability practices, and the impact of advancements in equipment and automation on brewing efficiency.	L4

Introduction of brewing, history of brewing; Raw materials: barley, hops, water, yeast; Adjuncts for beer production: Maize, rice, millet, wheat, sugar etc. Development of brewing techniques, global brewing products production trends.

UNIT II

Malt production, role of enzymes for malting; Barley storage, steeping, germination, kilning, cooling, storage; Malt from other cereals, caramel malt, roasted malt, smoked malt, malt extract; Malt quality evaluation.

UNIT III

Wort production, malt milling, Mashing, Mashing vessels; Wort boiling, clarification, cooling and aeration Enzyme properties, starch degradation, b-glucan degradation; Conversion of fatty matter, Biological acidification.

UNIT IV

Beer production methods, fermentation technology, changes during fermentation; Filtration procedure and equipment, beer stabilization conditions and durations, beer carbonation process; Packaging equipment and packaging materials. Powdered beer; production Technology**.**

UNIT V

Preventive Production of beer against technology, ling phenomenon of beer, possible measures against staling reactions, oxidation. Recent advances: Immobilized Cell Technology in Beer Production, immobilized yeast cell technology. Energy management in the brewery and malting; waste water treatment Automation and plant planning.

Textbooks

1. Kunze,W.*" Technology Brewing and Malting"*VLB Berlin, 5th Edition, 2019.
2. Esslinger, H. M. (Ed.). (2009). *Handbook of brewing: processes, technology, markets*. John Wiley & Sons.

References

1. Bamforth, C. W. (2016). *Brewing materials and processes* (Vol. 253). California: Academic Press.
2. Parker, D. K. (2012). Beer: Production, sensory characteristics, and sensory analysis. In *Alcoholic beverages* (pp. 133-158). Wood head Publishing.

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B.Tech FOOD ENGINEERING

R23 IIIRD YEAR SYLLABUS

	PROFESSIONAL ELECTIVE –III	L	T	P	C
		3	0	0	3
	FLAVOUR TECHNOLOGY				

Course Objectives

- To enable the student to understand basics of foods flavors
- To enable the student to understand chemistry & technology of natural flavors

Course Outcomes

UNIT I

COs	Statement	Bloom Level
CO1	To understand the basics of flavor	L3
CO2	To understand the correlation between appearance and taste	L3
CO3	To develop methods for stabilization of natural flavor	L3
CO4	To develop aroma chemicals	L3
CO5	To develop techniques for analysis of aroma chemicals	L4

Basics of flavors and colors olfactory perception of flavor and taste – Theories of olfaction Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavors – Natural, Nature identical, and syntheticFlavor potentiators. Methodology of sensory evaluation and determination of threshold levels as specified byBIS.E-nose technology

UNIT II

Extraction techniques Essential oils and oleoresins –Types of Extraction Solid-Liquid Extraction – Solvent Extraction-Supercritical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Solid-phase microextraction of aroma components –.

UNIT III

Technology of natural flavours Classification – Alliaceous flavors – Bittering agents, Coffee and Cocoa, Fruit flavors. Evolution of flavors during processing – enzymatic development, the effect of roasting, cooking frying on flavor developments. Flavor changes during the processing, preservation, packaging, and storage of foods. Roles as sulfur compounds, fatty acids, amino acids, terpenoids, lactic acid ethanol in food flavors.

UNIT- IV

Spices and herbs as food flavorings: Processing of basil, mint, saffron, cloves, tamarind, ginger, cardamom, chill, pepper, etc. for essential oils, extracts, and/or oleoresins. Liquid and dry flavor production - Staling of flavors. Microbial and cell suspensions in the synthesis of flavors.

UNIT V

Total component and headspace analysis of flavour- Total Component analysis– Basics and methods – Recent developments. Headspace analysis – static and dynamic methods – basic principles – method and developments.

Textbooks

1. Reineccius, G. (2017). *Flavor chemistry and technology*. CRCpress.
2. Socaciu, C. (2015). *Food colorants: chemical and functional properties*. CRCPress.
3. Damodaran, S., Parkin, K. L., & Fennema, O. R. (Eds.). (2007). *Fennema's food*

chemistry. CRC press.

References

2. Rowe, D. J. (2005). *Chemistry and technology of flavors and fragrances*,56. Blackwell.
3. Marsili, R. T. (1997). *Flavor, fragrance, and odor analysis*,203-227. Marcel Dekker.
4. Paredes-López, O., & Delgado-Vargas, F. (2003). *Natural colorants for food and nutraceutical uses*. CRC Press LLC.
5. Hendry, G. A. F., & Houghton, J. D. (Eds.). (1996). *Natural food colorants*. Springer Science & BusinessMedia.