Vision:

The Department of Biotechnology is committed to evolve as a world class science and technology centre by integrating quality and ethics in teaching and research.

Mission:

The mission of the department is:

- Empowering students with an unique multidisciplinary learning experience and fostering the young minds to develop as a researcher, entrepreneur, etc.
- Enhancing academic and industrial collaborative research initiatives for the development of biotechnological, food and therapeutic products.
- Emphasizing and equipping the students towards innovative industrial and research developments.
- Serving the society with utmost commitment, integrity, enthusiasm, and dedication.
ANNA UNIVERSITY, CHENNAI: 600 025
UNIVERSITY DEPARTMENTS
M. TECH. FOOD TECHNOLOGY
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM (CBCS)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
The Master's program in Food Technology curriculum is designed to prepare the graduates to

1. Design and develop technologies for industrial production of food products.
2. Analyse, evaluate and offer technical solutions for the food sector.
3. Participate in research and development projects leading to research degree.
4. Acquire innovative ideas and integrate with existing knowledge in the field.
5. Become an entrepreneur and be part of a supply chain management.

Programme Outcomes (PO)

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<td>1.</td>
<td>Ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>Ability to write and present a substantial technical report/document</td>
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<td>3.</td>
<td>Able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery shall be at a level higher than the requirements in the appropriate bachelor programme.</td>
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<td>4.</td>
<td>Able to identify, formulate and solve problems in areas of food storage, food processing &amp; preservation, analytical and sensory techniques, food packaging and food engineering.</td>
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<td>5.</td>
<td>Design new processes, modifying the existing system to improve the performance and to satisfy the constraints.</td>
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<td>6.</td>
<td>Apply various food analytical tools and techniques to improve the efficiency of the process and product.</td>
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PEO/PO Mapping:

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** Minimum of 4-week industry internship**
## SEMESTER III

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**LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

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FD3101 APPLIED STATISTICS AND NUMERICAL METHODS INFOOD TECHNOLOGY  C 3 1 0 4

OBJECTIVES
The course aims to
• train the students to address the mathematical problems involved in biological sciences
• educate students on methods of sampling, quantitative and statistical problems pertaining to food technology.

UNIT I  ROOT FINDING METHOD, SYSTEM OF LINEAR EQUATIONS AND INTERPOLATION 12

UNIT II  NUMERICAL INTEGRATION AND INITIAL VALUE PROBLEM FOR ORDINARY DIFFERENTIAL EQUATIONS 12

UNIT III  EMPIRICAL STATISTICS 12
Types of sampling – Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT IV  ESTIMATION THEORY 12

UNIT V  TESTING OF HYPOTHESIS 12
Sampling distributions – Type I and Type II errors – Tests based on Normal, t, 2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
CO1 Understand basic problem solving techniques.
CO2 Learn about advance integral and differential problems.
CO3 Understand different statistical analysis methods.
CO4 Appraise on estimation theory
CO5 Understand about sampling distribution

REFERENCES:
RM3151 RESEARCH METHODOLOGY AND IPR L T P C 2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap.

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9
Sampling, sampling error, measures of central tendency and variation; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

REFERENCES:

TOTAL: 45 PERIODS
FD3102 TRANSPORT PHENOMENA IN FOOD ENGINEERING  L T P C  3 1 0 4

OBJECTIVES
The course aims to
- Acquaint and equip the students with the principles of heat and mass transfer and in food processing
- Equip the students with the latest technologies of dehydration of food products and the design features of different dryers.

UNIT I ENGINEERING PROPERTIES AND HEAT TRANSFER 9

UNIT II MASS TRANSFER 9

UNIT III STERILIZATION PROCESS 9

UNIT IV MEMBRANE SEPARATION PROCESS 9
Membrane filtration spectrum - membrane materials and structures - membrane modules - principles of membrane filtration - microfiltration, ultrafiltration, reverse osmosis and nanofiltration processes - transport model, estimation of model parameters, Performance Characteristics, design of membrane systems – batch, feed and bleed systems, single pass system, diafiltration systems, co-current permeate flow system, pilot plant trials, sample design calculations - batch, feed and bleed systems, continuous system, operation of membrane systems, membrane applications in the food industry.

UNIT V DRYING AND DEHYDRATION 9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
OBJECTIVES

CO1 Analyse heat transfer, external and internal Resistance, finite objects and temperature time charts.
CO2 Understand validation of a thermal process a Methods of sterilization and equipment involved
CO3 Analyze industrial problems along with appropriate approximations and boundary conditions
CO4 Familiarize with batch, feed and bleed systems, continuous system, operation of membrane systems, membrane applications in the food industry.
CO5 enumerate principle and working of industrial dryers and design dryers specific for food products.

REFERENCES:

Course Articulation Matrix

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FD3103 FOOD STORAGE ENGINEERING

OBJECTIVES
The course aims to provide In-depth knowledge on safe storage of food materials and design of storage Structures for various categories of food products.

UNIT I FOOD GRAIN STORAGE
Grain storage principles- factors- changes during storage. indoor storage system- bag storage, bulk storage, bunkers, cap storage bags outdoor storage system — cold storage, hermetic storage, vacuum and gas storage - moisture movement during bulk storage of grains — pressure distribution in storage bins - grain storage structures - location and material selection for storage building - types - traditional, modern, temporary and permanent storage structures, factors affecting qualities of grains during packaging and storage, functional requirements of storage structures - traditional storage structures in india and their improvements

UNIT II DESIGN OF GRAIN STORAGE SYSTEM
Grain storage ecosystem- biotic and abiotic factors- moisture and temperature migration- cold spots and hot spots. aeration – cooling- dehydration in grain storage, grain storage in silos, bins and godowns-RCC and steel structures - aeration system for various storage structures, grain pressure theories - design of bulk storage structures, bag storage, godowns, theory and nature of grain flow, pressure distribution, flow patterns-hoppers and ducts — design - loading and unloading mechanism. Grain handling equipment - bulk handling of food grains - bulk conveying
equipment - design calculations, design and estimation of energy requirement and damage to biomaterials during mechanical handling - operational features - management and maintenance of grain storage, code of practices for safe storage of food grains.

UNIT III STORAGE OF FRUITS AND VEGETABLES 9
Harvest and pre-harvest factors, pre-storage treatments, controlled and modified atmosphere storage- effect of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, gas exchange modelling, effect of storage temperature on shelf life in cas and mas; storage of intermediate moisture foods - storage of dehydrated fruits and vegetables. Novel map applications for fresh-prepared produce - MAP gases - testing novel MAP applications - pack houses, CA and MA storage — principles, methods - optimization of storage gas composition, rate of supply, control systems for O2 and CO2. CA and MA transport technologies and applications.

UNIT IV COLD STORAGE SYSTEM 9
Food cooling and precooling, cooling process parameters – analysis – estimation of cooling time – for liquid, solid; food freezing process – freezing time estimation, design of food freezers, equipment for refrigeration of liquid, bulky foods and thin/particulate foods, vacuum cooling, cryogenic freezers, thawing. Ice manufacture: principles and systems of ice production basic types of ice, ice makers, treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; low temperature refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food defining overall shelf life, remaining shelf life in the context of chilled & frozen foods; - deterioration modes of food items; models of quality deterioration- kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf — life: general procedure for shelf—life testing — the 11 steps procedure. Accelerated shelf-life testing — steps procedure.

UNIT V COLD STORAGE DESIGN AND LOAD ESTIMATION 9
Cold storage — importance — types of cold store - Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, Products going in cold chain, their temperature and humidity requirements, construction of cold storage, equipment selection, insulating materials, vapour barriers, care and maintenance of cold storage, packaging needs and their compatibility in cold chain, Design of cold storage for food products— Meat product, Fishery Product, Dairy Products. Storage of food commodities - biochemical changes during storage - storage factors affecting losses, storage requirements, thermal design of structures Cooling/Refrigeration load calculations: Load sources, product cooling, conducted heat, convection heat, internal heat sources, heat of respiration, peak load, miscellaneous load Cold chain: Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration, components of cold chain, Cold chain maintenance, Repair and Replacement, refrigerated transport, cold chain and logistics management, Temperature recording devices used during transport, documentation and traceability.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student will be able to

CO1 Describe & analyse bulk storage, bunkers, cap storage bags, temporary & permanent storage structures
CO2 Understand theory and nature of grain flow, pressure distribution, flow patterns-hoppers and design of grain storage structures.
CO3 Differentiate the effect of storage temperature on shelf life of Intermediate moisture Foods - storage of dehydrated fruits and vegetables
CO4 Determine freezing Time, design food freezers and estimate shelf life of frozen food
CO5 Design cold storage facility, calculate refrigeration load & cold chain facility for food.

REFERENCES:

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Course Articulation Matrix

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FD3111 FOOD ENGINEERING LABORATORY L T P C
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OBJECTIVES
The course aims to educate students on applications of heat and mass transfer principles and enable students to develop models for optimization of process conditions for different food applications

LIST OF EXPERIMENTS
1. Determination of engineering properties of foods - density, particle size, porosity, colour, texture, viscosity, specific heat, freezing point depression.
2. Separation of immiscible phase using appropriate centrifuge, fractional distillation of multicomponent mixtures.
3. Determination of particle size index of powdered food materials.
4. Determination of freezing curves for selected fresh fruits and vegetables.
5. Convective heat transfer through IR radiation and its effect on baking of food products.
7. Calculation of D, Z and F values in retort and process time calculation.
8. Study of ultra-filtration and reverse osmosis separation process.
9. Performance evaluation of rapid extraction (filtration) for different particle size of fruits.
11. Canning and bottling of food products for commercial sterility.

OUTCOMES:
At the end of the course, the student will be able to:
CO1 Analyse optimize production processes, improve product quality, and ensure consistency in food manufacturing.
CO2 Construct efficient and reliable transportation of food particles which can lead to the design and implementation of improved pneumatic conveying systems in food processing industries.
CO3 Determine the desired process duration, and improve the quality and shelf life of food products.

TOTAL: 60 PERIODS
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FD3201 TRENDS IN FOOD PACKAGING SYSTEM

OBJECTIVES
The course aims to
- Educate and equip students with the latest food packaging technologies, enabling them to adopt these advancements in the food industry
- Facilitate students in gaining in-depth knowledge in the design and development of packaging systems for various categories of food products.

UNIT I PACKAGING SYSTEMS AND METHODS
Bag — in - box; microwave packaging; retort pouch technology, active packaging; intelligent packaging, antimicrobial packaging; bio-degradable packages, non-migratory bioactive polymers (NMBP) in food packaging - types and applications; application of nanotechnology in laminates, edible packages; bacterial production of polymer, packaging-flavour interactions, factors affecting flavour absorption, effect of irradiation of polymeric packaging material on the formation of volatile compounds, protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture. Case studies: packaging and lipid oxidation, modelling lipid oxidation and absorption shelf life evaluation of packaged food, package characterization and testing; time - temperature indicators (TTIs), defining and classifying TTIs, requirements for TTIs.

UNIT II PACKAGING MATERIAL CHARACTERIZATION AND EQUIPMENT
Paper and paperboard — raw materials, manufacturing stages, pulping techniques, types of paper, specialty papers; glass — types of glass, properties, glass manufacturing, bottle forming process & designs, usp; cartons – designs, manufacturing, applications, corrugated fibre boards, fibre drums; plastic – classification, glass transition, melting, degradation temperature, properties of plastic – PE,PP, PS, PVC, EVA, PA, EVOH, PLA and others; metals in packaging and their properties; container cleaning – air blast, ionized air blast, water rinse, wash and rinse, aggressive wash and rinse, sterilization, bottle orienting systems. Filling equipment and method - solid, liquid, semi - solid food -types of fillers - filler for glass bottle, paper bottle, pouches, plastic cup thermoforming equipment; form-fill - seal equipment, sealing equipment, labelling, and capping, canning and cartoning equipment. Industrial packaging: unitizing – shrink and stretch wrapping, palletizing, containerizing, rigid and semi-rigid containers; thermoformed packages – skin packaging and blister packaging; flexible containers; form – fill - seal systems.

UNIT III STRUCTURAL AND GRAPHIC DESIGN IN FOOD PACKAGING
Information required before designing a package for food product: product, targeted consumers,
marketing a product, branding requirements, style of packaging, budget — steps in designing of food packaging. Creating information architecture for printing, evaluation of packaging design, reuse of containers; child resistant package - design of security features, barcodes, RFID vision/inspection, metal detectors and x-ray inspectors, smart tracking systems, case study. Graphic design: typography, color, illustration, marketing studies, package aesthetics, decoration aspects. Closure design: function, types, selection considerations, closure dimensioning, metal closures, closure seals, plastic closures, injection moulds and closure design, tamper evident closures, child resistant closures. Special closures and functions.

UNIT IV  PACKAGING OF FRESH FOODS  
Food packaging laws and regulation, food labelling, packaging requirements for different foods and processing methods - general classification and packaging types, varieties and trends; packaging of convenience foods; packaging of food products — fresh fruits and vegetables, packaging of fruit juices, packaging of jams and jellies, packaging of pickles and chutneys; packaging of fats and edible oils, packaging of break - fast cereals, packaging of tea, coffee & other beverage products; packaging of soft drinks; packaging of bakery products - bread, biscuits & cakes; packaging of snack foods; packaging of ready - cook products; packaging of spices, condiments, oleoresins.

UNIT V  PACKAGING OF PROCESSED FOODS  
Packaging of meat and poultry products; packaging of fish and other sea - foods; packaging of dairy products ; packaging requirements for thermal -processed, dehydrated, frozen, irradiated and other specially processed foods - packaging for defence food, space food, high energy food for high altitude, functional foods, recent trends and advancements in food packaging  

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student will be able to

CO1 Demonstrate smart food packaging techniques and design indicators for food quality evaluation.
CO2 Identify and choose suitable packaging system for various food products:
CO3 Describe on morphology of packaging materials and design closures for food products
CO4 Describe food packaging laws & regulations and design a packaging system for shelf life extension of fresh food products
CO5 Construct a packaging system for shelf-life extension of processed food products

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OBJECTIVES
The course aims to familiarize students with advanced food processing techniques and their applications.

UNIT I  PRESSURE AND HEAT TREATMENT  9
Non thermal technologies in preservation of foods–necessity and advantages–status and trends of non-thermal technologies in preservation of foods-high pressure treatment of food–governing principles– process equipment, processing and effect on microorganisms -combined pressure-heat treatment on quality attributes of foods – effect on microorganism, texture, enzyme activity, nutrients – processing of salads and ready meals, high pressure freezing – ultra high static pressure, High hydrostatic pressure processing of cereals and pulses; high pressure CO2 processing of foods

UNIT II  ULTRASOUND, LIGHT AND MICROWAVE  9
Ultrasound–principle of operation–mechanism of inactivation of microorganisms and enzymes–uv light and pulsed light preservation–principles of operation–microbial inactivation mechanism, microwave technology-principle–application–sterilization, tempering, drying, puffing, coagulation and other processing applications, ultrasonic assistance of food freezing-power ultrasonic processing; electron beam processing of food

UNIT III  PEF AND OHMIC HEATING  9
Pulsed electric field–principles of operation–equipment–processing-control parameters–microbial inactivation mechanism–enzyme inactivation - effects on solid and fluid food - nutritional and quality parameters, ohmic heating–principle–equipment–effect on food quality and microbes inactivation- modelling of ohmic heating-ohmic heating application to specific foods

UNIT IV  MAGNETIC FIELD AND RADIATION PROCESSING  9
Introduction to irradiation technologies–general modification–equipment and operational parameters– food safety and shelf life of irradiated liquid foods-oscillating magnetic fields-magnetic fields- generation- mechanisms- inactivation of microorganisms – magnetic fields in food preservation, infra-red– mechanism of IR absorption by food–IR emitters and spectral bands – applications. induced electric field (IEF) – mechanism and application-oscillating magnetic field processing

UNIT V  OZONE, COLD PLASMA AND RF PROCESSING  9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
CO1 Understand the principles of high pressure treatment and its effect on microorganisms, texture, enzyme activity, and nutrients in food.
CO2 Analyze the effect of sound, light and electro-magnetic waves on processing and preservation of solid and liquid food.
CO3 Demonstrate principle, significance of electric current on microbial inactivation mechanism, and its effects on solid and fluid foods.
CO4 Describe and apply the principles of irradiation technologies, describe on mechanism of preservation, operational parameters, and the impact on food safety and shelf life of foods
CO5 Describe and demonstrate principles and significance of ozone, UV and RF for microbial inactivation
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FD3203 NON-DESTRUCTIVE QUALITY EVALUATION OFFOODS L T P C

OBJECTIVES
To provide students with theoretical knowledge and practical skills in non-destructive evaluation methods and imaging techniques for analysing food quality, defects, and structural characteristics, enabling them to effectively apply these techniques in the food industry.

UNIT I COLOUR AND MORPHOLOGY
Non-destructive equality evaluation methods—machine vision system—food image formation - acquisition—analysis—interpretation—enhancement—determination of size, shape and color of food products—gray and color image processing of food—morphological image processing—applications, colour analysis: optical aspects, CIE colour system, tristimulus color system, bridged methods, electronic nose, eye and e-tongue for sensory evaluation of foods

UNIT II IMAGING TECHNIQUES
Cereal grain microstructure analysis, imaging of double emulsion, imaging of fermented dairy products, kinetics of bubble growth in bread dough and crest formation, non-destructive imaging of cellular solid food, microstructure of gluten-free baked products, Soft X-ray systems—principles and methods of soft X-ray generation—image formation—detection and recording of X-ray image of food products—processing area—analysis techniques—determination of internal defects in fruits and vegetables; Hyperspectral imaging – principle and instrumentation

UNIT III ACOUSTIC SYSTEM
Fundamentals of acoustic resonance system—acoustics properties—measurement of acoustic resonance—impact device—sound capturing device—amplifiers—attenuation coefficient - digital signal analyzer – determination of maturity level of fruits and vegetables - application in fruit quality evaluation.

UNIT IV THERMAL IMAGING
Thermal imaging—NIR hyperspectral imaging—FTIR-operation and components—generation of image— acquisition—interpretation—Determination of internal defects and quality evaluation in food grains. Absorption and transmission of IR-Thermal pattern and anomalies interpretation-Ethical
consideration and safety.

UNIT V THERMAL AND FOOD MICROSTRUCTURE ANALYSIS


OUTCOMES:
At the end of the course, the student will be able to

- CO1 Utilize imaging techniques to analyze and interpret food colour and surface morphology
- CO2 Define and describe principles of generation, image formation, detection, and recording of X-ray images of food products.
- CO3 Demonstrate and develop a fundamental understanding of acoustic resonance systems, acoustics properties, and the measurement of acoustic resonance.
- CO4 Explain and analyze the hyperspectral images of food
- CO5 Apply and discuss thermal properties and illustrate food microstructure

REFERENCES:


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FD3211 ADVANCED FOOD PACKAGING SYSTEMS LABORATORY

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OBJECTIVES
The course aim is to facilitate students in acquiring in-depth knowledge of the design and development of packaging systems for various categories of food products.

LIST OF EXPERIMENTS
1. Design of cans for packaging of food product and analyzing its effect on product.
2. Multilayer packaging system development for food products.
   a) Design of package for modified atmospheric storage of any fruits or vegetables.
b) To study textural characteristics of selected fruit/vegetable under MAP storage
3. Testing of chemical resistance of various packaging materials
4. Evaluation of oxygen scavenger systems for food products
5. Designing and analysis of anti-microbial packaging for moisture sensitive foods
6. Examining migration of polymer residue from package to food
7. To design and evaluate performance of time temperature indicators
8. Determination of oxidative changes in packaged foods
9. Comparative evaluation of flexible and rigid packages for fragile foods
10. To Design an aseptic packaging system for highly perishable foods.
11. Determination of oil and grease resistant test for packaging films
12. Determination of respiration rate in fresh fruits and vegetables
13. Modelling flavour migration from packaging material

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, the student will be able to

CO1 Understand the principles of can design and its impact on food product preservation and quality.

CO2 Understand the concept and importance of multilayer packaging systems for food products.

CO3 Design packaging systems that maintain the desired gas composition for prolonging the shelf life of produce.

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FD3212 EMERGING FOOD PROCESSING TECHNIQUES LAB

OBJECTIVES
Course aims to educate students on modern food process techniques for the extension of shelf life and inculcate about mechanisms and identification and characterization of biomolecules

LIST OF EXPERIMENTS
1. To Determine the effect of combined heat and pressure treatment in food using High Pressure processor
2. To evaluate efficiency of ultrasound on inactivation of microorganism and enzymes in food products
3. To determine effect of UV treatment on sterilization of food products
4. To perform microwave sterilization of food
5. To produce puffed and flaked of food products.
6. To evaluate food microstructure by confocal microscopy.
7. To analyze, separate, identify and quantify of carbohydrates & amino acids of proteins through LC-MS.
8. To study on the In-vitro digestion process of various food products
10. To design three-dimensional processed food products
11. To optimize process parameters and produce a freeze-dried food products
12. To study on the In-vitro digestion process of various food products
13. To determine efficiency of PEF in shelf-life extension of liquid food.
14. Determination of Total Trans Fatty Acids using Infrared spectroscopy
15. To optimize process parameter for extraction of bioactive compounds using electrospinning technique.

**OUTCOMES:**
At the end of the course, the student will be able to

**CO1** Define the effect of combined heat and pressure treatment in food using High-Pressure Processor for Increased microbial safety and extended shelf life of the treated food products.

**CO2** Classify enhanced extraction of bioactive compounds and improved sensory characteristics

**CO3** Visualize and analysis of the internal structure of food product

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**Semester III**

FD3311 FOOD ANALYTICAL TECHNIQUES LABORATORY

**OBJECTIVE**
- The course aims to develop proficiency in utilizing advanced instrumentation and methods to analyse the chemical, physical, and sensory properties of food samples.

**LIST OF EXPERIMENTS**
1. Determining the Degree of Methylation and Acetylation of Pectin.
2. Determination of Neutral Sugars by Gas Chromatography of Their Alditol Acetates.
4. Separation, identification and quantification of flavours through GC-MS.
5. Identification and estimation of minerals present in food products through AAS.
6. Identification and quantification of pesticide residues in food ingredients and products through LC-QTOF.
7. Determination of absorbed oil content in fried foods and Monitoring the primary and secondary oxidative rancidity in oils.
8. Determination of Caffeine/sugars/benzoic acid in Beverages by HPLC.
10. Calculation of CIE colour specification of food products
11. To identify functional groups in food products, packaging material and adulteration using FTIR.
12. Production of probiotic food products
13. Production of food enzymes - amylase, protease, lipase
14. To examine application of enzyme to tenderize Meat.

**OUTCOME**
At the end of the course, the student will be able to

**CO1** Develop proficiency in utilizing advanced analytical techniques and instrumentation for the analysis of food samples.

**CO2** Apply appropriate methods and procedures to accurately quantify and evaluate specific chemical, physical, and sensory properties of food products.

**CO3** Demonstrate a thorough understanding of the principles underlying food analysis and the relevance of analytical techniques in ensuring food safety, quality, and compliance with regulatory standards.

**TOTAL: 60 PERIODS**
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FD3312 FOOD STORAGE ENGINEERING LABORATORY L T P C

OBJECTIVE
- The course aims to acquaint and equip the students with in-depth knowledge on safe storage of food materials.

LIST OF EXPERIMENTS
1. To study the Physical and thermal properties of grain
2. To evaluate the Grain drying and pressure drop in storage of grains
3. Analyse the Effect of humidity and temperature of storage on the quality of rice.
4. Design of packaging for storage of grains and effect of different packaging material on quality of grains.
5. Estimation of energy requirement and optimization for sieving of different grains to remove extraneous matters without affecting the grain structure.
6. Study on the effect of oxygen, nitrogen, and carbon dioxide on the storage of fruits and vegetables.
7. Effect of moisture content, water activity, and environmental conditions on the storage shelf life of fruits and vegetables.
8. Study the effect of rapid and gradual cooling on food products in walk-in cold storage system.
9. Study the effect on microbial load in Storage of food products in different refrigerated temperatures
10. Calculate the amount of energy required to freeze 1 kg of mango to 0, -5, -10, -15 and -20 ºC.
11. Effect of freezing and thawing cycle on the physical, chemical and microbial nature of food products in blast freezer.
12. Evaluate the effect of refrigeration and freezing on the cooked and uncooked food products. Calculate the energy requirement for both samples and also analyze the efficiency of the given process. Microscopic structural analysis of food products.
13. Study on effect of moisture content of the food product on the cooling and freezing load through the batch freezing system.
14. Evaluate the effect of retail packaging materials on the efficiency of refrigeration and freezing of food products. Correlate the insulating nature of packaging materials with the energy requirement for freezing and refrigeration.
15. Calculate the heat dissipated during respiration of fruits and vegetables, to optimize the necessary energy requirement for refrigeration in batch system for 24hr in batch storage
conditions.
16. Study on the effect of air and water as a cooling medium for food products.
17. Estimate the effect of liquid nitrogen freezing on fruits and vegetables.

**TOTAL: 60 PERIODS**

**OUTCOME**
At the end of the course, the student will be able to
CO1 Develop a comprehensive understanding of the physical and thermal properties of grains and their implications for storage, processing, and quality control in the food industry.
CO2 Understand the influence of humidity and temperature during storage on the quality attributes of rice, and apply this knowledge to optimize storage conditions and prevent quality deterioration.
CO3 Acquire proficiency in estimating energy requirements and optimizing sieving processes for grain cleaning, ensuring the removal of extraneous matter without compromising grain integrity.

**REFERENCES**

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**FD3313**

**INDUSTRIAL INTERNSHIP**
(4 WEEKS DURING II SEMESTER - SUMMER)

**OBJECTIVE:**
The course aims to
- Encourage the students to get connected with any food industry.
- Acquire knowledge on solving practical problems, gaining work experience and skills.

The students individually undergo training in reputed Food processing companies for a specified duration. At the end of the training, a report on the work will be prepared and presented by the student. Students will be evaluated through a viva-voce examination by a team of as per the regulations of University.

**OUTCOME**
At the end of the course the students will be able
CO1 Work in an industry
CO2 Contribute efficiently in a team and communicate with others
CO3 Gain practical knowledge and enhance their confidence and skills required to thrive in work place
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FD3314 PROJECT WORK I

OBJECTIVES
The course aims
- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination

TOTAL : 180 PERIODS

Course Content
Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

OUTCOMES:
On Completion of the course the student will be able to
CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Undertake problem identification, formulation and solution.
CO3 Design solutions to identified problems utilizing a systematic approach
CO4 Conduct experiment, interpret the result and prepare project report

The students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way

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Semester IV

FD3411 PROJECT WORK II

OBJECTIVES:
The course aims
- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

TOTAL :360 PERIODS

Course Content
The student should work on the selected topic as per the formulated methodology under the same
supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

**COURSE OUTCOMES**
At the end of the project the student will be able to
- CO1 Formulate and analyze problems for developing new methods/solutions/processes.
- CO2 Plan and conduct experiments to find solutions in a logical manner
- CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

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**FD3001 ENGINEERING PROPERTIES OF FOODS**

**OBJECTIVE**
The course aims to
- Acquaint and equip the students with different techniques of measurement of engineering properties and make the students understand the nature of food constituents in the design of processing equipment

**UNIT I SURFACE AND GAS EXCHANGE PROPERTIES**

**UNIT II ELECTRICAL AND COLORIMETRIC PROPERTIES**

**UNIT III THERMAL PROPERTIES**

UNIT IV RHEOLOGY OF FOOD PRODUCTS


UNIT V PROPERTIES OF FOOD POWDERS

Physical Properties - Density and Porosity, Particle Shape, Strength Properties - Hardness and Abrasiveness, Friability and Attrition, Compression Properties of Food Powders, Compression Methods, Compression Mechanisms during Uniaxial Compression Tests, Surface Area, Chemical and Physicochemical Properties - Instant Properties and Evaluation, Stickiness in Food Powders – Bridging, Thermodynamic Adsorption, Cohesion and Cohesion Properties, Test Methods, Water Activity and Glass Transition Temperature - Application of Compressing in Foods, Research Update in Food Powder Properties. Foodstructuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels. Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate significance of surface and gas exchange properties of food materials

CO2 Define, illustrate and explain electrical and calorimetric properties of food materials

CO3 Compare, examine and determine the effect of thermal processing on the structure and texture of food materials

CO4 Elaborate, examine and interpret the rheology of food products

CO5 Describe and characterize the physical and chemical properties of food powders

REFERENCE BOOKS


FD3002 FOOD PROCESS AUTOMATION

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**OBJECTIVE**
The course aims to inculcate students with the knowledge of automation of processes involved in the food industry

**UNIT I INTRODUCTION**
Food quality, automated evaluation of food quality, food quality quantization and process control, typical problems in food quality evaluation - beef quality evaluation; food odor measurement, continuous snack food frying quality. Data acquisition: Sampling elaboration with examples, concepts and systems for data acquisition such as: ultrasonic signal acquisition for beef grading, electronic nose data acquisition for food odor measurement, snack food frying data acquisition for quality process control, Image acquisition: elaboration with examples.

**UNIT II DATA ANALYSIS**
Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction etc.

**UNIT III MODELLING**
Modelling strategies: Theoretical and empirical modelling, Static and dynamic modelling, Linear statistical modelling, ANN modelling etc.

**UNIT IV PREDICTION**
Prediction and classification, Sample classification for beef grading, examples such as, based on linear statistical and ANN models, Electronic nose data classification for food odour pattern recognition, Snack food classifiation for eating quality evaluation based on linear statistical and ANN models, One-step-ahead prediction.

**UNIT V CONTROL**
Process control, internal model control, Predictive control, Neuro-fuzzy PDC for snack food frying process, Systems integration: Food quality quantization systems integration, Food quality process control systems integration, Food quality quantization and process control systems development

**OUTCOME**
At the end of the course the students will be able to

- **CO1** Describe and demonstrate the fundamentals of system integration for foods processing.
- **CO2** Identify, compare and evaluate the data collected.
- **CO3** Choose, explain, compare and analyze the models.
- **CO4** Describe, apply and interpret models for food quality evaluation.
- **CO5** Gain expertise in process control methodologies, including internal model control, predictive control, and neuro-fuzzy proportional-derivative controller (PDC), specifically for the snack food frying process.

**REFERENCE BOOKS**

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FD3003 FOOD PROCESS MODELLING AND SIMULATION  L T P C 3 0 0 3

OBJECTIVE
The course aims to
- Elucidate students with advanced knowledge in engineering modeling of the food processes
- Inculcate students with recent trends in development and simulation of process models for prediction and scale up.

UNIT I PROCESS MODELING 9
Introduction to Process Modeling: Balance equations and rate equations, mathematical models, empirical models and linear regression, systematic modelling approach, general property balance models in food processing, analytical solutions to ordinary differential equations, Laplace transformations and numerical methods in mathematical modeling.

UNIT II TRANSPORT PHENOMENA MODELS 9
Transport Phenomena Models: Equation of continuity, equation of energy, equation of motion, ODE models in food processing, transport phenomena models involving PDE, chart solutions to unsteady state transport problem, interfacial mass transfer, and rheological modeling.

UNIT III KINETIC MODELING 9
Kinetic Modeling: Kinetics and food processing, the rate expression, temperature effects on the reaction rates, enzyme catalyzed reaction kinetics, metabolic process engineering, microbial kinetics, kinetics of microbial death, model of ideal reactors, modeling batch and continuous thermal processing operations of foods.

UNIT IV MATHEMATICAL MODELING 9
Mathematical Modeling in Food Engineering Operations Moving boundary and other transport phenomena models for processes involving phase change, unit operation models:drying, baking, frying, evaporation, distillation, extraction, crystallization.

UNIT V MODEL SOLUTION AND SIMULATION TOOLS 9
Model Solution and Simulation tools MATLAB/ SCILAB/ SIMULINK as tools for solving mathematical models and for simulation. Solution strategies for lumped parameter models and distributed parameter models. Simulation of food manufacturing processes.

TOTAL 45 HOURS

OUTCOME
At the end of the course the students will be able to
CO1 Understand the fundamental principles of food process modelling
CO2 Identify, describe and develop mechanistic process models for unit operations in food
processing.

**CO3** Develop and validate food process models using experimental data and statistical techniques

**CO4** Evaluate and apply mathematical modeling for food engineering operations

**CO5** Describe and apply MATLAB, Scilab, and Simulink as tools for solving mathematical models and conducting simulations in the context of food engineering.

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**FD3004 ADVANCED FOOD FERMENTATION TECHNOLOGY**

**OBJECTIVE**

- The course aims to educate new fermentation processes and developments in the design of food fermenters and bioreactors.

**UNIT I MEDIA FOR FERMENTATION & STRAIN DEVELOPMENT**

Microbial culture, Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms; Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; optimization of fermentation media. Sterilization of media and air; Batch and Continuous sterilization, Thermal death kinetics Strain Development -Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains. Strain development by mutagenesis, protoplast fusion and transformation of cloned genes

**UNIT II TYPES AND DESIGN OF BIOREACTORS**

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Bioreactor configurations and types- Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors.

**UNIT III FERMENTATION PATHWAYS FOR INDUSTRIAL PRODUCTS**

Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by microorganisms; possibility of control of the reactions for the increased
formation of useful metabolites

UNIT IV ADVANCED FERMENTATION PROCESSES

Recombinant protein expression with E.coli and fermentation. Expression in yeast Pichia pastoris, production of recombinant vaccines, purification of recombinant proteins. Animal cell culture, Plant cell culture: Cell culture practices, nutritional requirement of cultured cell, cell growth and propagation, prevention and eradication of contamination, Cell synchronization; Cell cloning. Scaling-up of animal and plant cell culture.

UNIT V DOWNSTREAM PROCESSING

Various equipment for product recovery; micro-filters and Ultra-filtration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

OUTCOME

At the end of the course the students will be able to

CO1 Explain the preservation aspects of microbial cultures using recent advanced techniques.
CO2 Demonstrate and design food fermenters and bioreactors.
CO3 Describe and demonstrate biochemical pathway
CO4 Demonstrate and evaluate the kinetics and mechanism of microbial growth
CO5 Explain and illustrate applications of downstream processing in food industry,

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FD3005 DAIRY TECHNOLOGY

OBJECTIVE

The course aims to educate students with different techniques used in preservation of milk and milk products

UNIT I PROCESSING AND STORAGE OF MILK

equipments and working principles, hybrid technology for pasteurization of milk, microwave processing of milk.

UNIT II UNIT OPERATIONS AND MILK PRODUCTS


UNIT III ENZYME AND MICROBIAL INFLUENCE IN MILK PRODUCTS

Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations. Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals.

UNIT IV BY PRODUCTS AND ITS PROPERTIES

Protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, probiotic cheese and fermented Milks; bifidus factors in infant food formulations their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages. Vegan foods. Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners types properties and their applications in dairy and food industry.

UNIT V SHELF LIFE PARAMETERS AND PRESERVATION

Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products. Practical Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk systems; to study the various factors affecting the coagulation of milk by microbial rennets. Manufacture and evaluation of pro-biotic cheese and fermented milks; determination of glycolysis, proteolysis and lipolysis in cheese and fermented milk; enzymatic process for manufacture of low lactose milk whey products; preparation of caseinhydrolysis; visit to a bio-processing unit. Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

OUTCOME

At the end of the course the students will be able to

CO1 Classify, explain techniques involved in processing and storage of milk,
CO2 Describe and demonstrate methods involved in production of milk products
CO3 Select, explain and illustrate role of microbes and enzymes in development of milk products.
CO4 Demonstrate and Analyze production of bio-yoghurt, probiotic cheese and fermented Milks
CO5 Identify, explain and evaluate methods for shelf life extension of milk and milk products

TOTAL : 45 PERIODS

REFERENCE BOOKS

2. Engineering Aspects of Milk and Dairy Products, edited by Jane Selia dos Reis Coimbra, Jose A. Teixeira., CRC Press, 1st edition 2010

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FD3006 CEREAL AND GRAIN PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE
The course aims to Educate and equip students with latest cereal processing technologies for adoption in food industries and understand the various methods involved in safe storage of grains

UNIT I RICE PROCESSING 9

UNIT II WHEAT PROCESSING 9

UNIT III MAIZE PROCESSING 9
Maize – area and production – maize as food and feed- drying, cleaning, grading, sorting, packaging and storage - Milling process for maize- different unit operations- Beall degerminator – degermination with roller mills- Wet milling of maize – process - shelf life and spoilage.

UNIT IV MILLET PROCESSING 9
Area and production of barley, oat and millets – nutritive value of barley, oat and millets –drying, cleaning, grading, sorting, packaging and storage - processing of barley- equipment - finished products and end-uses of barley- Process involved in modern oat milling process- different unit operations involved in oat processing – different methods of millet processing – malting of millets - shelf life and spoilage.

UNIT V BY-PRODUCTS 9
Utilization of by-products - composition and nutritional value, consumption. Value addition - suitability of flour required for different products; Traditional process technique - parching, puffing, popping, roasting or toasting, frying, flaking, fermentation, extraction, malting - techniques - basic process - effectiveness in increase energy density, canning, papad process.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to

CO1 Describe and demonstrate unit operations involved paddy processing and examine quality
of finished product
CO2  Explain and illustrate the methods of processing cereals and utilization of its by-products
CO3  Enumerate on methods of processing maize
CO4  Describe and analyze different unit operations millet processing
CO5  Describe and demonstrate about utilization of various by-products

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FD3007  PULSE AND OILSEED PROCESS TECHNOLOGY  L T P C 3 0 0 3

OBJECTIVE
The course aims to enable the students to gain an insight into basic aspect of pulse and oilseed processing technology and understand the importance of primary secondary and tertiary processing of pulse and oilseed with special emphasis on their process and equipment.

UNIT I  INTRODUCTION  9
Concept of primary secondary and tertiary processing, concept of milling, Expression and extraction process. Application of different pretreatment on pulse and oilseed processing like parboiling, thermal treatment, enzymatic treatment and their effect on recovery and milling efficiency.

UNIT II  PULSE PROCESSING  9
Production and consumption of different pulses in Indian and world, Milling of Pulses, Machinery and equipment for pulse, Dry and wet milling of pulses, anti-nutritional factor and removal methods, effect of processing on nutritional value, Technology of legume based and blended extrudates, shelf life and spoilage of pulses

UNIT III  OIL EXTRACTION  9
Mechanical expression of oil – ghani, power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process –steps involved, batch and continuous-continuous solvent extraction process, Oil quality and standard quality regulations, shelf life and oxidative stability of oil, Other source of edible oil like corn germ, rice bran, almond oil, coconut oil.

UNIT IV  OIL REFINING AND PROCESSING  9
UNIT V  PULSE AND OILSEED PRODUCTS  
Legume based value added product, Instant dhal, Pulse flour products, soy based value added product, groundnut based value added product, fermented products, By product utilization of pulse milling, pulse broken, meal and cake utilization, lecithin, Technology of oilseed protein isolates  
TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 Understand the application of scientific principles in processing of pulse and oil seed
CO2 Identify, understand and explain specific processing technologies used for pulses
CO3 Describe and demonstrate various oil extraction methods
CO4 Explain and illustrate refining of oil and hydrogenated fat.
CO5 Identify, compare and analyse by-products derived from pulse and oil seed processing.

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FD3008  MEAT AND POULTRY PROCESS TECHNOLOGY  
L  T  P  C  3 0 0 3

OBJECTIVE
The course aims to impart knowledge about the advancement in the processing of meat poultry

UNIT I  SLAUGHTERING HOUSE AND EQUIPMENTS
Abattoir Layout, designing - equipment, operation and maintenance of slaughter houses and processing plants - hygiene and sanitary conditions in meat processing plant-pre- slaughter judging, inspection, grading of animals - Humane slaughter- principles and methods of stunning - machineries for slaughter and dressing. Automation in meat and poultry industry.

UNIT II  ADVANCES IN MEAT AND POULTRY INDUSTRIES

UNIT III  NOVEL MEAT PROCESSING TECHNIQUES
Novel processing methods in meat and poultry processing. Effect of high-pressure processing, pulsed electric field, Power ultrasound, Irradiation of meat and poultry product, changes in
protein, lipid and carbohydrate profile if any in meat due to processing.

**UNIT IV MEAT SAFETY AND QUALITY ANALYSIS**
9
Quality and safety analysis: Microbial analysis, Chemical analysis and Physical analysis. Instrumental analysis to ensure safety and quality: Adulteration in meat and meat products, IR analysis system for identification on type of meat, Mass spec. and Chromatographic analysis. Pathogenic microbe identification, Aspects of meat preservation for control of meat spoilage.

**UNIT V MEAT PACKAGING, BYPRODUCTS AND REGULATIONS**
9
Packaging of meat and meat products - modified atmosphere packaging - vacuum packaging-retort pouch processing – packaging of egg and egg products - utilization of by-products and wastes from meat and poultry processing industries - waste treatment and pollution control- Environmental Audits-Regulations on pollution control.

**OUTCOME**
At the end of the course the students will be able to

- **CO1** Understand and identify the specific processing technologies used for meat and such foods and the various products derived from these materials.
- **CO2** Demonstrate the changes in the composition of foods with respect to the type of processing technology used.
- **CO3** Understand and apply advanced preservation and packaging techniques for meat and poultry products.
- **CO4** Analyze and interpret about quality and safety analysis for meat and poultry
- **CO5** Identify and design a suitable packaging system for meat and meat products

**REFERENCE BOOKS**

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**FD3009 MARINE FOOD PROCESS TECHNOLOGY**

**OBJECTIVE**
The course aims to understand advanced concepts involved in the production, processing of marine products and study about quality assurance of marine products

**UNIT I INTRODUCTION**
Importance of marine products, fishing resources – inland, marine, blackish water fisheries - harvesting methods – crafts – gears
UNIT II  COMPOSITION AND QUALITY OF MARINE FOOD  9
Composition and nutritive value of marine – protein, omega 3 fatty acid, toxic component-
biochemical and microbiological changes in marine - evaluation of fish qualities - transportation
of fish, washing and grading.

UNIT III  PROCESSING OF MARINE FOOD  9
Processing of fish and shellfish – different types of ice and their advantage - freezing – individual
quick freezing – canning – salting – drying and dehydration - smoking of fish- Irradiation- fish
mince and surumi - packing, storage and transportation of chilled and frozen fish– packaging of
frozen fish – marketing - cold chain and export trade – transportation and marketing of frozen
products - packaging and packaging materials.

UNIT IV  MARINE FOOD PRODUCTS  9
Processing of fish and shellfish – different types of ice and their advantage - freezing – individual
quick freezing – canning – salting – drying and dehydration - smoking of fish- Irradiation- fish
mince and surumi - packing, storage and transportation of chilled and frozen fish– packaging of
frozen fish – marketing - cold chain and export trade – transportation and marketing of frozen
products - packaging and packaging materials.

UNIT V  SPOILAGE AND QUALITY CONTROL  9
Spoilage of marine products –quality control of fresh fish - quality control during freezing and
chilling - HACCP of marine products – quality assurance of marine products.

TOTAL: 45 PERIODS

OUTCOME
At the end of course, students will be able to

CO1  Classify and define marine species.
CO2  Describe and demonstrate on composition of marine meat and assess quality of marine
food product
CO3  Explain on various methods of marine food preservation and create a suitable method for
shelf life extension.
CO4  Describe and develop food products related to marine foods
CO5  Understand and assess the level of Spoilage and quality of marine products

REFERENCE BOOKS
1. Andrew L. Winton, Kate Barber Winton,. Fish and Fish products Agro Botanical
3. Gopakumar, K. Fish Packaging Technology (Materials and Methods) concept publishing

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FD3010  SPICES, CONDIMENTS AND PLANTATION PRODUCTS  L T P C
3 0 0 3

OBJECTIVE
The course aims to study about processing of spices and plantation crops and understand
the technology used for their processing, preservation and value addition.
UNIT I       SIGNIFICANCE OF SPICES AND CONDIMENTS

Spices and Condiments - Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate, processing of spices like chilli, turmeric pepper, ginger etc.

UNIT II       POWDERS

Spice Powders and Curry Powders: importance in culinary preparations, preparation methods, grinding and packaging methods for spice powders like chilli powder, turmeric powder, ginger powder, garlic powder; and Masala Powders for chicken masala, meatmasala, biryani masala, chat masala etc. Importance of Cryogenic grinding of spices.

UNIT III       ESSENTIAL OIL AND OLEORESINS

Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamom etc. Extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc. Extraction of Oleoresins- Concept and importance of oleoresins in food processing, solvent extraction of oleoresins. De- solventization methods, regulatory and statutory requirements for oleoresin processing.

UNIT IV       TEA AND COFFEE

Plantation crops-description of various types of plantation crops viz. coconut, areca nutcoffee, tea, cocoa etc. Production and processing of Tea leaves: Black tea, Green tea and Oolong tea. Chemistry of tea manufacturing and tea quality; tea aroma precursors; tea flavour; tea grades; storingof tea Instant tea, tea concentrates, decaffeinated tea, flavoured tea; herbal tea. Production and processing of coffee cherries by wet and dry methods to obtain coffee beans, grinding, storage and preparation of brew, Soluble /Instant coffee. Use of chicory in coffee, decaffeinated coffee, coffee concentrate.

UNIT V       COCOA AND COCONUT


OUTCOME
At the end of the course the students will be able to

CO1 Define and describe process spices, spice powders, essential oil and oleoresins.
CO2 Explain and illustrate steps involved in processing of spices and spice products
CO3 Understand and appraise method of extraction of essential oil and oleoresins
CO4 Describe and demonstrate methods involved in processing of plantation crops
CO5 Describe and analyze about the production, processing and preservation of cocoa beans and coconut

TOTAL : 45 PERIODS

REFERENCE BOOKS
FD3011 BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES L T P C 3 0 0 3

OBJECTIVE
The course aims to educate students about the Origin and type of waste and by products, waste identification, classification and composition.

UNIT I FOOD INDUSTRY BY-PRODUCTS AND WASTE 9
Status in India, definition, origin and types of waste and by-products, their identification, classification, composition and characterization, need for treatment and utilization, impact on environment, food waste as source of biogenic raw material and energetic utilization, legal and statutory requirements for food waste handling, treatment & disposal.

UNIT II INTRODUCTION TO FOOD WASTE TREATMENT 9
Basic unit operations, techniques & equipment for treatment, primary treatments like screening, sedimentation, skimming, flotation coagulation & flocculation, flow equalization, filtration, adsorption, chemical oxidation, membrane separation, ion exchange. Anaerobic & aerobic digestion of organic wastes, activated sludge process, biomass generation & its utilization.

UNIT III FOOD WASTES AND BY-PRODUCTS RELATED TO SPECIFIC PROCESSING INDUSTRIES 9
Fruit and vegetables, dairy industry, oil and oil seeds industry, sugar industry, grains and milling industry, fermentation industry, livestock and poultry, fish, meat processing industries, Spice processing industries etc.

UNIT IV WASTE UTILIZATION AND CASE STUDIES 9
Utilization of whey for protein extraction and beverages from dairy industry, Utilization of specific plant by-products for recovery of proteins, pectins, dietary fibres, antioxidants, colorants etc., Utilization of biomass for production of animal feed, Extraction of leaf protein, banana fibre, pectin from waste of fruits, lycopene from tomato waste, starch manufacuture, production of gelatin, utilization of egg shell, extraction of oil from wheat germ, corn germ and rice bran, Extraction of protein from oil cake, deoiled rice bran etc., soap formation, toffee/pinnifrom ghee residue.

UNIT V AGRO WASTE 9
Farm wastes, solid waste management and its disposal, Biogas generation, Biofuel, production of food packaging materials from agro waste, Compost/Vermicompost, Future Trends.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 Understand and appraise the basics of by-products generated in various food processing industries
CO2 Describe and demonstrate wastes generated and the methods to dispose & to treat the wastes
CO3 Identify waste from various food processing industries, compare and explain
conversion of waste to value added products

**CO4** Explain and illustrate methods of utilizing waste

**CO5** Describe management of agro waste

**REFERENCE BOOKS**


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**FD3012 FLAVOUR TECHNOLOGY**

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**OBJECTIVE**

The course aims to provide in-depth knowledge on food flavouring materials and flavour compounds involved in development of flavour and the analytical techniques involved in flavour analysis and mechanisms of flavour perception.

**UNIT I SOURCES AND TYPES OF FOOD FLAVOURS**

Principal types of flavourings used in foods, Nature-identical flavouring substances, Artificial flavouring substances, Flavour constituents from onion, garlic, cheese, milk, meat, vegetables, fruits; Flavour constituents of wine, coffee, tea, chocolate, spices and condiments, Fragrance oil (Vanilla, Mandarin orange, Cinnamon, Lemongrass, Peppermint etc.) essential oil flavour. Basics of flavour, flavour and taste perception, smell and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, Aroma compounds, flavour profile, bio-flavour and reconstituted flavour.

**UNIT II FLAVOUR COMPOUNDS**

Methods of flavour extraction, isolation, separation; Distillation, solvent extraction, enzymatic extraction, static headspace, dynamic headspace etc Flavouring materials: natural flavouring, derivatives of spices, essential oils, oleoresins, fruits and fruit juices and concentrates. Aromatic vegetable flavours, flavours derived from processing and roasting, enzymatically derived and modified flavouring, flavours made by fermentation, pyrolysis, biotechnology role to produce flavour, production of natural flavour by microbial and enzymatic action. Flavour intensifier/ potentiators – chemistry and technology, classifications – traditional, yeast extract, table salt as Flavour potentiators, HVP, MSG and 5' - Nucleotides – toxicity, other potentiators umami tasting glutamate conjugates, alapyridaine, sweetness potentiators, maltol and ethyl maltol, cyclic enolones.

**UNIT III PROCESS FLAVOURS**

Process flavours: Effect of processing on organoleptic quality of food, flavour precursors, flavour development on cooking, microwave heating, roasting, baking, smoking, boiling, cooling, freezing, caramelization, fermentation, pathway for flavour formation via maillard 41 41 reaction, kinetics of maillard reaction and flavour formation, flavours from lipids, deep fat fried flavours, Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting
stabilization of encapsulated flavour and their applications in food industry – Effect of storage, processing, transportation and environmental conditions on flavour components.

UNIT IV FLAVOUR ANALYSIS 9
Sample preparation and Aroma Isolation, methods of aroma isolation, instrumental analysis of aroma isolates – GC, GC/O, GC-MS/O, E-nose, Taste compounds – volatile and non volatile compounds, off – flavour and taints in food, sensory aspects of off-flavour testing – due to chemical change, microbes.

UNIT V FLAVOUR LEGISLATION 9
Flavour legislation, Modelling flavour release, Useful principles to predict the performance of polymeric flavour delivery systems, Delivery of flavours from food matrices, Packaging and flavour compounds interaction On-line monitoring of flavour processes, Sensory methods of flavour analysis.

TOTAL: 45 PERIODS

OUTCOME
Upon completion of the courses, student can

CO1 Identify and understand the various mechanisms of flavour formation and flavour release
CO2 Explain metabolic routes leading to flavour formation in plants
CO3 Demonstrate and appraise off-flavour defects in foods and strategies of identification.
CO4 Discriminate, analyse and assess extracted and isolated flavour compounds.
CO5 Understand the legislation and regulations related to flavouring substances in food products.

REFERENCE BOOKS

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FD3051 FUNCTIONAL FOODS

OBJECTIVE
The course aims to impart the knowledge on the importance of functional ingredients and nutraceuticals and utilization of functional ingredients in development of new food products including health foods, functional foods and specialty foods.

UNIT I IMPORTANCE OF MICRONUTRIENTS AND BIOACTIVE COMPONENTS 9
Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks...
etc. Infant nutrition and dietary Formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods.

UNIT II FOOD FORTIFICATION
Food fortification - techniques for fortifying foods with minerals and vitamins, High protein foods prospective nutraceuticals for fortification of foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in foods.

UNIT III FOOD FOR HEALTH SIGNIFICANCE

UNIT IV FOOD FOR DISEASE CONTROL
Definition and various classes of phytochemicals, Special foods/nutrients their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulfur compounds, flavonoids, carotenoids, etc. Special foods/nutrients for persons suffering with milk allergy and lactose intolerance with special emphasis on nutrients and foods. Sports foods – ingredients, components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition.

UNIT V CLASSIFICATION AND SAFETY
Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classes of nutraceuticals and functional foods. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods, recent advances in different categories and type of foods, Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and symbiotics.

OUTCOME
At the end of the course the students will be able to

CO1 Explain the concept of Functional Foods and differences with food supplements, fortified foods, novel foods and medicines
CO2 Acquire proficiency in formulation and delivery functional food products.
CO3 Describe and demonstrate the role of food in nutritional well being.
CO4 Explain and illustrate the diverse classes of phytochemicals and their significance in promoting health, preventing diseases, and enhancing the immune system,
CO5 Develop a critical understanding to judge the difference between marketing and consumer perception and scientifically based knowledge regarding potential future Functional Foods

TOTAL: 45 PERIODS

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FD3013  FOOD LEGISLATION AND STANDARDS  

OBJECTIVE
The course aims to provide in-depth knowledge in topics related to food legislation and standardization and insight for the students in food manufacture and in food trade.

UNIT I  INDIAN FOOD REGULATIONS  
Need for food regulation, Food Safety and Food Standards Act 2006, Food Safety and Standards Authority of India (FSSAI) structure and functions, scientific committees and panels under FSSAI, Rule and Regulation making process.  
Food Safety and Standards Act, 2006 and the regulations made thereunder like Licensing and Registration, Packaging and Labelling Regulation, Food Products Standards and Food Additives Regulation, Nutraceutical Regulation, Claim Regulation, Contaminants and Toxins Regulation.

UNIT II  PRODUCT SPECIFIC INDIAN REGULATIONS  
Indian Food Regulation - Food product categorization, Use of food additives in different products, Processing aid regulation New product/additive approval Food Product Recall, BIS mandatory certified products, Packaged Commodity Rules, AGMARK, etc including latest amendments.

UNIT III  INTERNATIONAL FOOD REGULATIONS  

UNIT IV  PUBLIC HEALTH AND NUTRITION REGULATION  

UNIT V  FOOD SECURITY AND SAFETY LEGISLATION  
Internalizing Externalities: Techniques to Reduce Ecological Impacts of Food Production, Cooperatives and Producer Organizations Roles in Achieving Food Security, Governing the Global Food System Towards the Sustenance with Artificial Photosynthesis.  
Food Safety and Policy, Trade, Labelling Law - European Food Law, United States and Canada, Australia and New Zealand, Africa, Asia, Association of Southeast Asian Nations (ASEAN).

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to

CO1 Identify the Agency responsible for legislation & implementation when facing a problem concerning a food

CO2 Describe about Food product categorization and explain the Use of food additives in different products

CO3 Explain and illustrate international food regulations

CO4 Describe and demonstrate national and international regulations for foods with nutraceutical benefits

CO5 Review legislative approaches for the management of food safety
REFERENCE BOOKS

FD3014 CONTROL OF FOOD INFESTATIONS

OBJECTIVE
The course aims to inculcate in-depth knowledge about pest infestation and its associated risk.

UNIT I FOOD INFESTATION
Post harvest problems of infestation in stored food grains, spices and processed foods and food processing units; Economic losses and safety issues.

UNIT II COMMON PESTS
Common pests involved in food storage and handling: pests and their habits: rodents, cockroaches, flies, ants, stored product insects – beetles, weevils, moths; birds and other vertebrates.

UNIT III RISK FROM PESTS
Risk posed by pests to foods, food handlers and public; contamination, toxicology and microbiology, transmission of pathogens, food infection and food poisoning. Food hygiene: regulations, GHP and GMP relevant to pest control.

UNIT IV PEST PREVENTION
Pest prevention- E-R-D Exclusion, restriction, destruction in food operations; building design and pest proofing, warehousing and storage areas, water and drains. Waste collection and disposal.

UNIT V PEST CONTROL
Inspection and auditing, physical methods: use of monitoring traps/detectors – electric flycontrol units, pheromone traps; Chemical control methods – use of insecticides, pesticides and rodenticides, safety and environmental consideration of chemicals used for control, biopesticides; fumigation and disinfection; Pest awareness training and education. Integrated Pest Management in the food industry, Regulatory aspects of pest management.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to

CO1 Understand and appraise post-harvest issues in stored grains and processed foods
caused by pests

CO 2 Identify, classify and describe on the types of pests
CO3 Describe and demonstrate role of pest in safe handling of food
CO4 Explain and illustrate on pest prevention techniques
CO5 Analyze about Regulatory aspects of pest management

REFERENCE BOOKS

FD3015 ESTABLISHMENT AND MANAGEMENT OF FOOD INDUSTRY SYSTEMS L T P C 3 0 0 3

OBJECTIVE
This course aims to inculcate students with management skills required for the start-up of the food industry.

UNIT I OVERALL DESIGN OF AN ENTERPRISE
Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout: location factors, plant site selection. Location theory and models, industrial buildings and grounds. farm level collection and Chilling center. Space requirement.

UNIT II PREPARATION OF A PLANT LAYOUT

UNIT III PRACTICAL ASPECTS OF DESIGNING PLANT LAYOUT

UNIT IV LICENSING AND REGISTRATION
FSSAI regulations: Central Licensing Authority- Registration of Petty Food Business- License for food business- Conditions of License- Sanitary and hygienic requirements- food operations and controls -Management and Supervision - Food Testing Facilities - Audit, Documentation and Records

UNIT V FUNDING AGENCIES
Technology development funds-NRDC, DSIR; Funds for patent protection- Ministry of
MSME, NIF; Technology in licensing funds - DSIR; Technology scale-up/ validation/ de-risking funds - DST, SIDBI, DIT; Market entry funds - NIF, KITVEN, Ministry of new and renewable energy, Angel network; Expansion funds - Venture capitalists, NABARD, Small and medium stock exchanges, Venture Funds with Govt. of India involvement.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 Understand the basics of designing a plant.
CO2 Describe, demonstrate and prepare a plant layout.
CO3 Identify and appraise the practical aspects of designing a plant layout.
CO4 Understand and apply FSSAI regulations at various stages of business establishment.
CO5 Analyze Technology development funds.

REFERENCE BOOKS

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FD3016 ADVANCED INSTRUMENTATION FOR FOOD SAFETY AND QUALITY

OBJECTIVE
This course aims to impart advanced knowledge on the principles and instrumentation of spectroscopic and chromatographic hyphenated techniques used in food safety and quality assessments. This course also emphasizes on inculcating knowledge on modern analytical instruments that are used for food testing.

UNIT I HPLC ANALYSIS OF FOOD

UNIT II GCMS ANALYSIS OF FOOD
Gas Chromatography: Gas chromatography Introduction, sample preparation, principle of separations, components gas supply system, injection port, oven, column and stationary phases, types of columns, detectors different types of detectors, recorder, types of carrier gases used. Gas liquid chromatography: principle; different types of detectors and its applications: discharge ionization detector (DID), electron capture detector (ECD), flame photometric detector (FPD), Hall electrolytic conductivity detector (EICD), helium ionization detector (HID), Nitrogen phosphorous detector (NPD), mass selective detector (MSD), photo ionization detector (PID), pulsed discharge ionization detector (PDD), thermal energy analyzer (TEA); various applications of GLC. Gas chromatography-mass spectrometry (GC-MS): principles and applications in foods, flavors and fragrances, residue analysis of veterinary hormonal substances and endocrine disruptors, identification of terpenes.
UNIT III  LCMS ANALYSIS OF FOOD  9

UNIT IV  NON DESTRUCTIVE TECHNIQUES IN FOOD ANALYSIS  9
Non Destructive Techniques in Food Analysis: optical methods like visible, NIR, and FTIR spectroscopy; computer vision, delayed light emission and fluorescence; X-ray imaging for classifying food products based on internal defects; nuclear magnetic resonancetechniques; ultrasonics; firmness measurement methods; linear visco-elastic methods; biosensors in food quality evaluation, new techniques for food quality data analysis and control.

UNIT V  MICROBIAL TECHNIQUES IN FOOD ANALYSIS  9
Microbial techniques in food analysis: Infectious and toxigenic agents of food borne diseases: detection, identification and control methods. Antibiotic resistant strains; methods of detection, conventional, modern, rapid methods, genetic approaches. Molecular based techniques in food analysis: Gel Electrophoresis of Plasmid DNA, Polymerase Chain Reaction (PCR) & Sequencing; Setting up a Gene-Specific Polymerase Chain Reaction, Gel Electrophoresis of Gene-Specific PCR Products, Determining DNA Concentration Using Fluorometer, Amplification of cDNA Using PCR, Sequencing of Gene-Specific Products. Real-time PCR assay for detection of microbial spoilage of foods.

TOTAL: 45 PERIODS

OUTCOME
At the end of course, students will be able to
CO 1 Demonstrate, analyze, construct and assess quality of food using HPLC
CO 2 Demonstrate, analyze, construct and assess quality of food using GCMS
CO 3 Demonstrate, analyze, construct and assess quality of food using LCMS
CO 4 Demonstrate, analyze, construct and assess quality of food using Non-destructive techniques
CO 5 Demonstrate, construct microbial analytical techniques.

REFERENCE BOOKS
1. Nielsen, S.S. Introduction to the chemical analysis of foods. Jones and Bartlett Publishers,

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FD3017  FOOD SAFETY AND RISK ANALYSIS  L T P C
3 0 0 3

OBJECTIVE
To inculcate students about food safety and risk analysis for the modern day foods and food
based products

UNIT I OVERVIEW OF FOOD SAFETY

The importance of food safety, how food borne illness affects consumers and retailers, how poor safety practices affect food products. Food hazards, the food business, the responsibilities of the managers, Penalties applicable to poor food handlers, Enforcement officers, Basic rules regarding personal hygiene, good manufacturing and hygiene practices at various sectors of food processing.

UNIT II INTRODUCTION TO RISK ANALYSIS


UNIT III RISK MANAGEMENT

Introduction, Definitions of key Risk Management Terms, General principles of Food Safety Risk Management, General Risk Management Framework: Preliminary Risk management activities, selection of risk management options, implementation of risk management decisions, monitoring and review. Role of food chain professionals in Risk Management: Self-monitoring and company Laboratory Accreditation, Guides to good hygiene practices, the development of company certification, product standardization, contribution to product traceability

UNIT IV RISK ASSESSMENT

Introduction, Definitions related to risk assessment, principles of Food safety risk assessment, scientific approaches for assessing risks, responsibilities of risk managers in commissioning and guiding a risk assessment, general criteria of risk assessment, risk assessment methodology, risk assessment for chemical hazards, risk assessment for biological hazards, Biotechnology risk assessment, sensitivity analysis, validation, establishment of ‘Targets’ in the food chain as Regulatory standards

UNIT V RISK COMMUNICATION

Introduction, Understanding risk communication, the goals of risk communication, key communication stages during food safety risk analysis, role and responsibilities for risk communication, principles of risk communication, some practical aspects of risk communication.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand about Basic rules regarding personal hygiene, good manufacturing and hygiene practices at various sectors of food processing

CO2 Understand and explain the principles of risk analysis, and how to utilize it to make decisions related to food safety and other health issues.

CO3 Describe and demonstrate the risk management decision process

CO4 Enumerate on various risk assessment techniques

CO5 Understanding risk communication, the goals of risk communication.

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FD3018 BEVERAGE TECHNOLOGY

OBJECTIVE
The course aims to educate students on basic ingredients used in production of alcoholic and non-alcoholic beverages and familiarize students with regulations and quality control involved in beverage industry.

UNIT I BASIC INGREDIENTS IN BEVERAGES
Beverage-definition-why we drink beverages-ingredients- water, carbon dioxide, bulk and intense sweeteners, water miscible and water dispersible flavouring agents, colours – natural and artificial, Micro and nano emulsions of flavours and colors in beverages, preservatives, emulsifiers and stabilizers. Plant based beverages – fruits, vegetables, cereals and pulses.

UNIT II BEER AND WINE

UNIT III CARBONATED BEVERAGES
Procedures-carbonation equipment-ingredients-preparation of the Syrups-Filling system-packaging containers and closures

UNIT IV NON-CARBONATED BEVERAGES
Coffee bean preparation-processing-brewing-decaffeination- instant Coffee-Tea types- black, green and oolong- fruit juices, nectars, quash, RTS beverages, isotonic Beverages. Flash pasteurization, Canning and Aseptic Packaging of beverages

UNIT V PACKAGING AND QUALITY CONTROL
Packaging of beverages – selection and effectiveness of pack, Effective application of quality controls, brix, acidity to brix ratio, single strength of juice- sanitation and hygiene in beverage Industry-Quality of water used in beverages - threshold limits of various ingredients according to PFA, EFSA and FDA – Absolute requirements of Soluble solids and titrable acidity in beverages. TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 Understand various concepts, principles and procedures involved in processing of beverages.
CO2 Demonstrate various unit operations involved in the food beverage manufacturing.
CO3 Describe and demonstrate the methods of manufacturing carbonated beverages
CO4 Explain and illustrate methods of manufacturing non-carbonated beverages.
CO5 Analyze the regulations and standards related to ingredient thresholds and quality parameters.

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FD3019 FOOD NUTRIGENOMICS L T P C 3 0 0 3

OBJECTIVE

The course aims to familiarize students with the basic concepts in nutritional genomics and to develop an understanding of genomics and gene regulation with respect to diet and obtain an appreciation for the role and importance of nutrition in prevention of polygenetic diseases.

UNIT I GENE-DIET INTERACTIONS 9

UNIT II MODULATING DISEASE RISK 9
Modulating the risk of cardiovascular disease through nutrigenomics; Modulating the risk of diabetes through nutrigenomics; Modulating the risk of inflammatory bowel diseases through nutrigenomics; Modulating the risk of obesity through nutrigenomics; Modulating the risk of cancer through nutrigenomics; Modulating the malnutrition through nutrigenomics.

UNIT III GENOMICS AND PROTEOMICS TECHNIQUES 9

UNIT IV METABOLOMICS AND COMPUTATIONAL APPROACHES 9
Metabolomics techniques: Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders. Computational approaches: Introduction to different types of public domain databases, data mining strategies, primer designing.

UNIT V NUTRIGENOMICS 9
Bringing nutrigenomics to the food industry: Industry-Academia partnerships as an important challenge; Bringing nutrigenomics to the public: direct-to-consumer testing and future of nutritional genomics, Interaction with health professionals in bringing nutrigenomics to the public; status of contemporary society for nutrigenomic science, Public health significance of nutrigenomics and nutrigenetics.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand about Nutrigenomics approaches to unraveling physiological effects of complex foods
CO2  Analyze about Modulating the risk of inflammatory bowel diseases through nutrigenomics
CO3  Differentiate between Different sequencing approaches, Micro array, Mass array, SNP genotyping, PCR and RT-PCR techniques
CO4  Define Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders
CO5  Bringing nutrigenomics to the public

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FD3020 FOOD INFORMATICS

OBJECTIVE
The course aims to educate students on basics of bioinformatics and structural modelling of food ingredients and the biological sequences including next generation sequencing data, tools and analysis and applications in food relevant topics

UNIT I INTRODUCTION TO BIOINFORMATICS AND SEQUENCE ANALYSIS
Molecular sequences - Biological databases - Food specific Databases - Plant Databases - Sequence Alignment - Local and Global Alignment - BLAST family of programs - Multiple sequence alignment and its applications - Introduction to Phylogenetics - Building UPGMA - Neighbour Joining - Parsimonious and Maximum Likelihood trees.

UNIT II OMICS TECHNIQUES, NEXT GENERATION SEQUENCING DATA AND APPLICATIONS
Genome sequencing, Sequencing Pipeline, Genome sequences of fermentation related microorganisms, Lactic Acid Bacteria, Comparative genomics and tool, NGS Data Resources, GEO and SRA databases, RNA-Seq Data Analysis, Differential Gene expression analysis

UNIT III PROTEIN STRUCTURE, MODELING AND DOCKING
Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Taste receptors and their structures, Molecular docking and applications, Ligand interactions with taste receptors

UNIT IV MICROBIOME, MICROARRAYS AND OTHER ADVANCED TOPICS
Microbiome; Beneficial effects of diet and microbiome modulation; Microarrays, Clustering
techniques for microarray analysis; Introduction to Systems Biology; Metabolic networks; Metabolomic data resources, Building Stoichiometric matrices; Metabolic modeling

UNIT V APPLICATIONS OF INFORMATICS IN FOOD INDUSTRY

Enzymes in food industry, Systems Biology applications of metabolic modeling for strain improvement in fermentation, NGS data analysis for detection of food related pathogens, Comparative Genomics of food related pathogens. Laboratory Demonstrations for Biological Databases, Sequence alignment: BLAST family of programs, Crustal Omega for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Auto Dock, NGS Data resources

OUTCOME

At the end of course, student will be able to

CO1 Understand about BLAST family of programs, Multiple sequence alignment and its applications
CO2 Analyze about GEO and SRA databases
CO3 elaborate on Prediction of Secondary Structure and Tertiary Structure
CO4 Understand about Beneficial effects of diet and microbiome modulation
CO5 Differentiate among Systems Biology applications of metabolic modeling for strain improvement in fermentation

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FD3021 FOOD PRODUCT DESIGN AND DEVELOPMENT

OBJECTIVE

The course aims to familiarize students with design, develop and scale up of food products and regulations in quality, safety and marketing of food products

UNIT I FOOD NEEDS & CONSUMER PREFERENCE

Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept; advantages of processed foods in urbanised Modern Society; why people buy processed foods. Developing a Product to Meet the Requirements

UNIT II DESIGNING NEW FOOD PRODUCTS

New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; recent
developments in food ingredients/additives flavourings, colorings, emulsifiers, stabilizer and sweeteners; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

UNIT III  STANDARDIZATION & LARGE-SCALE PRODUCTION
9
Process design, equipment needed and Design; establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis

UNIT IV  QUALITY, SAFETY & REGULATORY ASPECTS
9
Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product

UNIT V  ADVERTISEMENT, MARKETING & CASE STUDIES
9
Product performance testing; market positioning, Marketing: developing test market strategies; various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors; Case Studies of some successes and failures- Factors that influence NPD success, innovation case studies to highlight best practice in terms of the integration of technological and marketing approaches to NPD; food choice models and new product trends.

TOTAL: 45 PERIODS

OUTCOME
At the end of course, student will be able to

CO1  Describe and demonstrate various aspects of Creativity, Innovation and New Product Development

CO2  Design and develop new food products

CO3  Understand methods of standardization and apply for scaling up of production

CO4  Explain and Analyse about standard product and conformation to standards

CO5  Familiarize with food choice models and new product trends

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OBJECTIVE
The course aims to inculcate students with knowledge on principles and significance of the sensory perception mechanism

UNIT I PRINCIPLES AND SIGNIFICANCE 9
Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation, test protocol considerations; Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses.

UNIT II FLAVOURS AND ODOUR 9
Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste;

UNIT III SENSORY MEASUREMENTS 9
Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Interrelationship between sensory properties of food products and various instrumental and physio-chemical tests.

UNIT IV SENSORY QUALITY EVALUATIONS 9
Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, statistical interpretation of results, dilution procedures, descriptive sensory analysis, contour method, other procedures.

UNIT V MARKET ANALYSIS 9
Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey

TOTAL: 45 PERIODS

OUTCOME
At the end of course, student will be able to
CO1 Describe and demonstrate basic anatomy and physiology of the sensory organs used to evaluate food
CO2 Define, classify and understand mechanism of flavour and odour perception
CO3 Understand, design and undertake sensory testing using different types of methodologies
CO4 Understand how to analyse sensory data and draw appropriate conclusion
CO5 Understand the factors that influence acceptance and preference in consumer behaviour

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FD3023 ADVANCED FOOD MICROBIAL ANALYSIS  

OBJECTIVE
The course aims to educate students on significance of microbial metabolism in food and application of food microbiology in preservation and safety of food

UNIT I MICROBIOLOGY OF FOODS
Fresh and fermented foods; common food borne bacteria and fungi – their general roles; parameters effecting microbial growth – extrinsic and intrinsic, combined intrinsic and extrinsic lactic antagonism and hurdle concept; growth kinetics

UNIT II MICROBIAL METABOLISM AND THE FOOD MATRIX
CHO metabolism, chemiosmotic theory of ATP synthesis; degradation of aromatics, alicyclics, aliphatics, alkenes, aromatic; anaerobic respiration, fermentation, chemolithotrophy, phototrophy; synthesis of carbon compounds. Action of microbes on food components; nature of microbial growth in food; principles of structural, mechanical and dynamic characteristics of food systems; introduction to predictive microbiology

UNIT III METHODS OF BACTERIAL IDENTIFICATION
Microbial genomics and the microbiome; morphological, physiological, biochemical, immunological/serological, phage typing, chemotaxonomic, numerical, molecular methods; genome sequencing, gene mapping

UNIT IV APPLICATIONS OF FOOD MICROBIOLOGY
Beneficial uses of bacteria in food; intestinal probiotics; concept of prebiotics, synbiotics; techniques for characterizing functional properties; problems of the food matrix; technologies for encapsulation; food and beverages for certain target groups; modified foods; stability and preservation of microbe functionality during processing; biosensors

UNIT V BIO-FUNCTIONALITY AND SAFETY OF FOOD
Toxicokinetic; mechanistic principles of toxic effects; genotoxicology and carcinogenesis; functionality and potential dangers of food ingredients; effect of food additives; structure and chemistry of the most important residues and contaminants in food and feed; modern methods for their determination; requirements for trace analysis; microbial examination of food – recommended and supplementary tests

TOTAL: 45 PERIODS

OUTCOME
At the end of course, students will be able to
CO1 Discuss the incidence and types of microorganisms in foods
CO2 Describe microbial metabolism and its interactions with the food matrix
CO3 Analyse different methods of bacterial identification, including morphological,
physiological, biochemical, immunological.

**CO4** Explain the effects of fermentation in food production and how it influences the microbiological quality and status of the food product.

**CO5** Asses the bio-functionality and safety aspects of food, including toxico-kinetics, toxic effects, genotoxicology, food additives, residues and contaminants in food

**REFERENCE BOOKS**

**Course Articulation Matrix**

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**FD3024** APPLICATIONS OF ENZYMES IN FOOD INDUSTRY

**OBJECTIVE**
The course aims to provide in-depth knowledge on enzymes used in food product development and application of enzymes in purification and their impact on sensory and nutritional quality

**UNIT I** INTRODUCTION TO ENZYMES USED IN FOOD INDUSTRY

Classification of enzymes, Objectives of using enzymes in food processing and in food product development, Merits and demerits of using enzymes, Sources of enzymes, Microbial enzymes and their advantages/ disadvantages, Commercially important enzymes used in food industry and their mode of action, Overview of applications of enzymes in the food industry, Newer enzymes and their actual and potential applications, fermentative production of enzymes (amylases, proteases, cellulases, pectinas, xylanases, lipases) used in food industry and their downstream processing

**UNIT II** ENZYMES IN PLANT PRODUCTS PROCESSING

Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides. Fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanases andpentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); Oilseeds processing, formation of TAGs

**UNIT III** ENZYMES IN ANIMAL PRODUCTS PROCESSING

Enzymes as processing aids: Role of enzymes in cheese making and whey processing; meat and meat processing (meat tenderization); egg processing, extraction of fish oil, seafood (like surimi product), poultry, eggs. Animal feed
UNIT IV ENZYMES FOR PRODUCTION OF FOOD ADDITIVES
Enzyme processing for flavours through biotransformation’s (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides; flavours from hydrolysed vegetable/animal protein); enzymatic approach to tailor-made fats, Enzymes as additives e.g. antioxidant or antimicrobial

UNIT V ENZYMES FOR FOOD PACKAGING & OTHER APPLICATIONS
Novel food applications of enzymes, Enzymes in active packaging and in edible coatings and films, Safety of enzymes used in foods, food grade enzymes, Immobilization of enzymes for food applications, Recombinant enzymes from GMO

OUTCOME
At the end of course of course, students will be able to

CO1 List different enzymes applied in processing of foods
CO2 Describe and demonstrate the applications of enzymes in the production of various plant and animal products in food industries
CO3 Explain and illustrate the role of enzymes in the production of food additives and novel applications on food packaging as sensors
CO4 Demonstrate the role of enzymes as additives in the food industry, including their use as antioxidants or antimicrobial agents.
CO5 Apply the knowledge about the use of enzymes inactive packaging and edible coatings and films

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FD3025 NANOTECHNOLOGY IN FOOD APPLICATIONS

OBJECTIVE
The course aims to expose the students with the advanced concepts of nanotechnology and use of nanotechnology in processing and packaging of foods

UNIT I NANOPARTICLES- INTRODUCTION AND PREPARATION
UNIT II CHARACTERIZATION TECHNIQUES

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques - AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT III NANOTECHNOLOGY IN FOOD PROCESSING


UNIT IV NANOPACKAGING

Nanopackaging for enhanced shelf life- Potential of nanomaterials in food packaging-Nanopolymers, Nanocomposites, Nanolaminates and Nanostructured Coatings in Food Packaging- Smart/Intelligent packaging- Nano antimicrobials in enhancement of shelf-life of foods

UNIT V NANO SENSORS

Nanotechnology in Microbial Food Safety & bio-security- Electrochemical sensors for food analysis and contaminant detection- Monitoring and separation of food-borne pathogens using nanoparticles- Safety Assessment for Use of Nanomaterials in Food and Food Production-Efficacy Evaluation and Risk Assessment- Regulatory Framework for Food Nanotechnology

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate different methods for preparation and characterization of important properties of nanomaterials, commonly used in food sector

CO2 Enumerate nanoparticles applications in different food technology operations like processing & packaging

CO3 Acquire knowledge on food safety components using nanomaterials

CO4 Analyze about the Potential of nanomaterials in food packaging like Nano polymers, Nanocomposites, Nanolaminates

CO5 Explain and apply Regulatory Framework for Food Nanotechnology

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FD3026  GENETIC ENGINEERING AND GENETICALLY MODIFIED FOODS

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OBJECTIVE
To educate students on
- genetically modified plants, transgenic animals and their engineering method
- genetically modified microorganisms & their applications in foods

UNIT I  BASICS OF RECOMBINANT DNA TECHNOLOGY
Manipulation of DNA and RNA — Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophages, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods.

UNIT II  DNA LIBRARIES
Construction of genomic and cDNA libraries, Artificial chromosomes — BACs and YACs, Screening of DNA libraries using nucleic acid probes and antisera.

UNIT III  SEQUENCING AND AMPLIFICATION OF DNA
Maxam Gilbert’s and Sanger’s methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP, PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR — SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

UNIT IV  TRANSGENIC TECHNOLOGY
DNA microinjection, Retroviral vectors, Transgenic animals — Knock in and knock out animals, Transgenic plants – Ti plasmid.

UNIT V  APPLICATIONS OF TDNA TECHNOLOGY IN FOODS
Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria: Chymosin, Lite beer; Tryptophan; Transgenic plants: Calgene Flavr Savr TM tomato, Monsanto Round-Up TM Ready, Ciba GeigyBasta TM resistant crops; Edible vaccines: Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
1. Understand genetically modified plants, animals and modified microorganisms
2. Describe and demonstrate applications of genetically engineered plants
3. Explain Risk and safety assessment of the GM foods and their label.
4. Apply the genetically modified microorganisms and their applications in foods
5. Explain and illustrate the applications of genetically engineered organisms and rDNA technology in foods.

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FD3027  FOOD STRUCTURING TECHNIQUES  L T P C
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OBJECTIVE
The course aims to
- Introduce the techniques of developing structured food products.
- Educate the technical and functional performance of structured food materials.

UNIT I  INTRODUCTION
Nature of food structure, Food structure development, Role of hydrocolloids and proteins in food structure development, making of structured foods, Destruction, destabilization and deformation of food matrix, Application of materials science in food design and development of engineered food materials, the systematic approach to food engineering systems (SAFES), Complex Disperse System (CDS) formalism, Top-down and Bottom-up strategies of constructing food matrix. Modelling and Computer Simulation Approaches to Understand and Predict Food Structure Development.

UNIT II  TECHNIQUES FOR FIBROUS STRUCTURE FORMATION
Cultured meat, Mycoprotein, Wet spinning, Electrospinning, Extrusion, Mixing of proteins and hydrocolloids, Freeze structuring, Shear cell technology. Food Printing: 3D food printing; Approaches, Technologies in food printing, Printability of food components, Factors affecting the printability, 4D Printing; Concept and Functionality, smart food materials, shape memory effect in 4D food printing, Deformation and breakup, Coalescence and alignment, Applications of 3D and 4D food printing.

UNIT III  FOOD STRUCTURE DEVELOPMENT IN EMULSION SYSTEMS
Emulsions: Principles and Preparation, Basic constituents of Food emulsion, Emulsion architecture, Microstructure design and performance. Food Structure Development in Oil and Fat Systems; nanoscale crystals and the structures of lipids and fat, fat crystal network. Role of bubbles in food structure development; Formation of foam/bubble microstructures, Rheological behaviour, Characteristics of bubble-containing structures.

UNIT IV  STRUCTURING POLYPHASIC FOOD SYSTEMS

UNIT V  PERFORMANCE OF STRUCTURED FOOD
Food Structure Development for Rheological/Tribological Performance; structure-property oral process relationships. Developing Food Structure for Mechanical Performance; structure and bulk behavior of soft solid foods, particulate composites and gels, cellular solid foams, and short fiber-reinforced foods. Design Structures for Optimal Sensory Performance, Development of Food Structures for the Encapsulation and Delivery of Bioactive Compounds.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
- Understand the techniques of developing structured food products.
- Enumerate the concepts and principles of food structuring.
- Describe and demonstrate modern techniques of food structure development.
- Evaluate the technical and functional performance of structured food materials.
- Explain the & illustrate the food Structure for Mechanical Performance

REFERENCE BOOKS

Course Articulation Matrix

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FD3028 FOOD SUPPLY CHAIN MANAGEMENT

OBJECTIVE
This course aims to educate students on operational strategies, tools and techniques involved in supply chain management of agri-food sector and their intriguing correlations.

UNIT I SUPPLY CHAIN AND QUALITY MANAGEMENT 9
Introduction, actors in supply chain management, supply chain vs. value chain, factors affecting quality in supply chain management, challenges in supply chain and quality management, pricing and performance measurement in supply chains.

UNIT II FOOD SUPPLY CHAIN MANAGEMENT SYSTEMS AND INSTITUTIONS 9
Introduction to FSMS - ISO, GFSI, BRC, IFS, SQF, FSSC, HACCP, Codex, BIS and BIS standards, QCI, EIC, EPC and export regulation, AEPDA, FSSAI and FSSAI Act

UNIT III MARKETING AND QUANTIFYING SUPPLY CHAIN 9
An overview, product differentiation and quality standards, major players in supply chain, marketing channels and legislations, case studies: national and international supply chain management of horticultural produce.

UNIT IV ERP IN SUPPLY CHAIN 9
Introduction to Enterprise Resource Planning (ERP), inventory management, manufacturing, sales and purchase module, finance module, supply chain management, customer relationship management, HR management module.

UNIT V LOGISTICS & DISTRIBUTION MANAGEMENT 9
Physical distribution, distribution channels, channel conflict management, big data analysis, block technology, internet of things, artificial intelligence and sensor based traceability systems in supply chain.

TOTAL: 45 PERIODS

OUTCOME
After successful completion of this course, students will be able to

CO1 Understand basic principles, strategies and dynamics involved in supply chain management
CO2 Comprehend various food supply chain management systems and their regulations.
CO3 Apply knowledge to evaluate and manage an effective supply chain in agri-hotri produce
CO4 Correlate the fundamentals of logistics and distribution management to evaluate quality management during supply chain
CO5 Analyze and improve supply chain system in food sector

REFERENCE BOOKS
2. R. Accorsi and R. Manzini (2016) Sustainable food supply chains-Planning, design, and
control through interdisciplinary methodologies, Elsevier.


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FD3029 INVENTORY MANAGEMENT  
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**OBJECTIVE**

This course aims to educate students on principles of logistics, different models, statistics, modelling systems, system organization and overall aspects of Enterprise Resource Planning (ERP).

**UNIT I** INTRODUCTION TO INVENTORY MANAGEMENT  
9

Fundamental Principles of Inventory Management and Cost of Inventory, Understanding Lean Management Planning for Inventory Management, Inventory Performance Measurements and Inventory Turnover, Role of Inventory in the Logistics Process and Organization.

**UNIT II** INVENTORY MODELS  
9

Basic Inventory Models, Discrete Lot-Sizing Techniques, Basic Sizing Models and Decision Rules; Independent Demand Inventory Systems, Dependent Demand Inventory System, Deterministic Inventory Models, Probabilistic Inventory Models. JIT Model and its Importance in food processing industry.

**UNIT III** INVENTORY SYSTEM PLANNING  
9

Manufacturing Systems and Models Fundamental, Manufacturing Planning & Scheduling Fundamental, Shop Scheduling with High Product Mix, Heuristics-based Planning and Scheduling, Hands-on - Heuristics-based Planning and Scheduling.

**UNIT IV** SIMULATION MODELLING SYSTEMS  
9


**UNIT V** ERP IN INVENTORY MANAGEMENT  
9


**TOTAL: 45 PERIODS**

**OUTCOME**

After successful completion of this course, students will be able to
CO1. Comprehend the dynamics of inventory management’s principles, concepts, and techniques as they relate to the entire supply chain.
CO2. Understand the methods used by organizations to obtain the right quantities of stock or inventory.
CO3. Describe the functions and costs of an inventory system.
CO4. Understanding of inventory management and control practices.
CO5. Apply different methods and practices to address inventory management problems.

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