DEPARTMENT OF BIOTECHNOLOGY
ANNA UNIVERSITY, CHENNAI

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.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
The Masters 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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<tr>
<td>1.</td>
<td>Ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>2.</td>
<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>They will be 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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## PROGRAM ARTICULATION MATRIX

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UNIVERSITY DEPARTMENTS
M. TECH. FOOD TECHNOLOGY
REGULATIONS – 2023
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** Minimum of 4-week industry internship **
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**TOTAL NO. OF CREDITS: 71**

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# LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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# CREDIT SUMMARY

M.Tech Food Technology

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OBJECTIVES
The course aims to
- train the students to address the mathematical problems involved in biological sciences
- understand various 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.

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:
COURSE ARTICULATION MATRIX

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RM3151 RESEARCH METHODOLOGY AND IPR

L T P C
2 1 0 3

OBJECTIVES:
To impart knowledge on
- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I RESEARCH PROBLEM FORMULATION
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
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING
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
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
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.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,

FD3102 TRANSPORT PHENOMENA IN FOOD PROCESS

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

UNIT II MASS TRANSFER

UNIT III STERILIZATION PROCESS

UNIT IV MEMBRANE SEPARATION PROCESS
Membrane filtration - 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


OUTCOMES:

At the end of the course, the student will be

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 Gain knowledge about pulse combustion drying: principle, combustors design and construction, types of combustors, Hybrid drying technologies.

REFERENCES:


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FD3103 FOOD STORAGE ENGINEERING

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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
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
Food cooling and precooking, 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
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
- 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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FD3111  ENGINEERING LABORATORY

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OBJECTIVES
The course aims to educate 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.
6. Construction of weibull diffusion model for diffusion of water out of food samples during osmosis.
7. Calculation of D, Z and F value 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.
13. Texture and Colour Measurement of foods

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

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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

OUTCOMES:
At the end of the course, the student will be
 CO1 Define and demonstrate active & Intelligent 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

REFERENCES:
OBJECTIVES
At microbial Pulsed heat of non thermal technologies in preservation of foods

OUTCOMES:
control efficacy of ozone processing
Generation of ozone
UNIT V
field – preservation, infra parameters
Introduction
UNIT
microbes
processing; electron beam processing of food and microwave Ultrasound
UNIT processing of foods pressure, High hydrostatic nutrients
UNIT thermal methods applications. Additionally, we emphasize the importance of understanding the effects induced electric field (IEF) on thermal technologies in preservation of foods

TD3202 EMERGING FOOD PROCESSING TECHNIQUES

FD3202 EMERGING FOOD PROCESSING TECHNIQUES

OBJECTIVES
The course aims to familiarize students with advanced food processing techniques and their applications. Additionally, we emphasize the importance of understanding the effects of novel non-thermal methods on the quality and safety of food products.

UNIT I PRESSURE AND HEAT TREATMENT
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
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
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
Introduction to irradiation technologies—general modification—equipment and operational parameters— food safety and shelf life of irradiated liquid foods-oscillating magnetic fields-magnetic files- 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
Generation of ozone—batch and continuous process of ozone for inactivation—factors affecting efficacy of ozone processing—effect on food quality—methods of generation of cold plasma – control parameters- batch and continuous method of cold plasmatreatment for decontamination. radio wave frequency— principle—factors influencing RF heating process—applications

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student will be
CO1 understand the principles of high pressure treatment and its effect on microorganisms,
texture, enzyme activity, and nutrients in food.
CO2 analysing of effect of sound, light and electro-magnetic waves on processing and preservation of solid and liquid food.
CO3 knowledge on principle, significance of electric current on microbial inactivation mechanism, and its effects on solid and fluid foods.
CO4 understand 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.

REFERENCES:

Course Articulation Matrix

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FD3203 NON-DESTRUCTIVE QUALITY EVALUATION OF FOODS L T P C 3 0 0 3

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 9

UNIT II IMAGING TECHNIQUES 9
UNIT III ACOUSTIC SYSTEM

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
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  L  T  P  C  
0 0 4 2

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
CO1 Understand the principles of can design and its impact on food product preservation and quality. The effects of can design on the shelf life and sensory attributes of food products.
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 LABORATORY  L  T  P  C  
0 0 4 2

OBJECTIVES
Course aims to educate students about 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 perform structural elucidation of proteins through MALDI-TOF.
8. To evaluate food microstructure by confocal microscopy.
9. To analyze, separate, identify and quantify carbohydrates & amino acids of proteins through LC-MS.
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 electrosprning technique.

TOTAL: 60 PERIODS

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

CO1 Define the effect of combined heat and pressure treatment in food using High-Pressure Processor: Increased microbial safety and extended shelf life of the treated food products.
CO2 Classify enhanced extraction of bioactive compounds and improved sensory characteristics
CO3 Visualization 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 methodsto 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 theprimary 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
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 evaluatespecific chemical, physical, and sensory properties of food products.
CO3 Demonstrate a thorough understanding of the principles underlying food analysisand the relevance of analytical techniques in ensuring food safety, quality, and compliance with regulatory standards.

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FD3312 FOOD STORAGE ENGINEERING LABORATORY

OBJECTIVE
The course aims to acquaint and equip the students with in-depth knowledge on safe storage of food materials. And to analyse the effect of various storage Structures for various categories of food products.

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 materialon quality of grains.
5. Estimation of energy requirement and optimization for sieving of different grains toremove extraneous matters without affecting the grain structure.
7. Effect of moisture content, water activity, and environmental conditions on thestorage shelf life of fruits and vegetables.
8. Study the effect of rapid and gradual cooling on food products in walk-in cold storagesystem.
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 °C.
11. Effect of freezing and thawing cycle on the physical, chemical and microbial nature offood 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

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.

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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 companies for the specified duration. At the end of the training, a report on the work will be prepared and presented by the
Students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME
At the end of the course the students will be able to
CO 1 To work in an industry
CO 2 To contribute efficiently in a team and communicate with others
   CO 3 To gain practical knowledge and enhance their confidence and skills required to thrive in workplace

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FD3314 PROJECT WORK I

OBJECTIVE:
The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution.

COURSE CONTENT:
Students should identify one project that can be carried out in two phases either in-house or in industry. When working outside, an internal guide from the department will monitor and review progress of work.

OUTCOME:
At the end of the course the students will be able to
CO1 develop employability skills
CO2 improve problem solving ability
   CO3 improve presentations skills and secure hands-on experience

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Semester IV

FD3411 PROJECT WORK II

OBJECTIVE:
The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution.

COURSE CONTENT:
Students should extend their projects based on the preliminary research work during phase I. When working outside, an internal guide from the department will monitor and
OUTCOME:
At the end of the course the students will be able to
CO1 develop employability skills
CO2 improve problem solving ability
CO3 improve presentations skills and secure hands on experience

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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 Compression in Foods, Research Update in Food Powder Properties. Food structuring: 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.

TOTAL 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 understand the importance of food polymers
CO2 understand the effect of various methods of processing on the structure and texture of food materials
CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation
CO4 Develop a comprehensive understanding of rheology and its application in the characterization and evaluation of food products
CO5 knowledge of the physical and chemical properties of food powders, including density, porosity, particle shape, strength properties, and chemical composition

REFERENCE BOOKS
FD3002 FOOD PROCESS AUTOMATION

OBJECTIVE
The course aims to
develop knowledge of students in the automation of processes involved in the food industry and
familiarize in the areas of data analysis, modelling, predictive control of different
processing steps in food industry.

UNIT I INTRODUCTION
Food quality, automated evaluation of food quality, food quality quantization and process control,
typical problems in food quality evaluation eg., 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 classification 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

TOTAL 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 understand fundamental of system integration for foods processing.
CO2 develop and manage automation of processes in their future industrial ventures.
CO3 acquaint with different techniques of automation in Food Processing.
CO4 utilizing prediction and classification techniques, including linear statistical models, artificial
neural networks (ANN), and electronic nose data analysis, for various food-related applications.
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 and 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 modeling 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 gain knowledge on development of simulation models for various food processes
CO2 understand the importance of Computer applications for perfection and automation.
CO3 familiarize students to solve the mathematical model equations using numerical technique
CO4 evaluate mathematical modeling for food engineering operations, specifically focusing on transport phenomena models involving phase change and unit operation models
CO5 describe 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 L T P C
3 0 0 3

OBJECTIVE
The course aims to gain knowledge about fermentation technologies used in food industry learn role of microorganisms in fermentation gain skills to control of fermentation processes

UNIT I MEDIA FOR FERMENTATION & STRAIN DEVELOPMENT 9
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 9
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- Bubblecolumn, 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 9
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 9
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 9
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.

TOTAL: 45 PERIODS

OUTCOME
At the end of the course the students will be able to
CO1 gain knowledge on principles of fermentation technology and operations of fermenter.
CO2 familiarize control systems of a fermenter and isolation of products and its purification.
CO3 design fermentation system which can be exclusively used in industries
CO4 comprehensive understanding of advanced fermentation processes, including the expression of recombinant proteins using E. coli and yeast Pichia pastoris.
CO5 knowledge and skills required for the production, purification, and characterization of recombinant proteins,

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FD3005 DAIRY TECHNOLOGY

OBJECTIVE
The course aims to
impart the knowledge about processes that are carried out in development of different dairy products in industry, and familiarize Students with different techniques used in preservation
of milk and milk products

UNIT I  PROCESSING AND STORAGE OF MILK  9

UNIT II  UNIT OPERATIONS AND MILK PRODUCTS  9

UNIT III  ENZYME AND MICROBIAL INFLUENCE IN MILK PRODUCTS  9
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 innovationsin 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  9
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 lactosefor 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 byproducts; bio-sweeteners types properties and their applications in dairy and food industry.

UNIT V  SHELF LIFE PARAMETERS AND PRESERVATION  9
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 understand dairy products processing methods,
CO2  gain knowledge on special manufacturing processes of cream separation, Protein hydrolysates, functional dairy foods and others
CO3  have practical knowledge on analysis of milk and milk products.
CO4  Analyze production of bio-yoghurt, probiotic cheese and fermented Milks
CO5  Understand Current trends in cleaning and sanitization of dairy equipment

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 – degeneration 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 prepare themselves for possible industrial endeavours.
CO2 understand utilization of by-products from cereals
CO3 gain knowledge on milling, parboiling and other products
CO4 analyze different unit operations involved in oat processing and different methods of millet processing
CO5 describe and demonstrate about utilization of various by-products

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FD3007 PULSE AND OILSEED PROCESS TECHNOLOGY

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, antinutritional 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  9
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  process pulse and oil seed
CO2  process Value added products from pulse and oil seed
CO3  application of practical knowledge of pulse milling and oil extraction techniques.
CO5  Analyze about pulse flour products, soy based value added product.

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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 from a food engineer view point.

UNIT I  SLAUGHTERING HOUSE AND EQUIPMENTS  9
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
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
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.

TOTAL: 45 PERIODS

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 grasp 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 about quality and safety analysis for meat and poultry
- CO5 Learn about packaging of meat and meat products

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### FD3009 MARINE FOOD PROCESS TECHNOLOGY

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#### 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

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

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 surimi - 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

Fish meal, bone meal, fish oil, surgical sutures from intestine, chitin and chitosan -fermented fish products – fish paste products (fish sausage and ham, etc.) – fish protein concentrates- utilization of fish processing

#### UNIT V SPOILAGE AND QUALITY CONTROL

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

- **CO1** have in depth knowledge on handling and transportation of marine products.
- **CO2** process marine and their by-products
- **CO3** understand quality of marine products and quality issues in post-production and factors affecting the quality
- **CO4** Analyze about fish protein concentrates and utilization of fish processing
- **CO5** Understand about Spoilage of marine products

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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 9
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 9
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 9
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 9
Plantation crops-description of various types of plantation crops viz. coconut, areca nut, coffee, 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; storing of 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 9
Production, processing and chemical composition of cocoa beans. Cocoa Processes: Cleaning, roasting, alkalinization, cracking and fanning, Nib grinding for cocoa liquor, cocoa butter and cocoa powder. Manufacturing process for chocolate: Ingredients, Mixing, Refining, Conching, Tempering, Moulding etc. to obtain chocolate slabs, chocolate bars. Enrobed and other confectionary products. Composition, Structure and characteristics of cashew nut and other dry fruits. Coconut - processing and preservation methods, Value added and shelf stable products viz., bottled coconut water, desiccated coconut powder, processed products from cocoa like chocolate.

OUTCOME
At the end of the course the students will be able to
CO1 process spices, spice powders, essential oil and oleoresins.
CO2 learn about steps involved for different plantation products
CO3 process spices and plantation products
CO4 knowledge about various types of plantation crops such as coconut, areca nut, coffee, tea, and cocoa
CO5 analyze about the production and processing of cocoa beans,

REFERENCE BOOKS
1. ASTA,. Official analytical methods of the American Spice Trade Association, 4th Edition
FD3011 BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES

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

UNIT I FOOD INDUSTRY BY-PRODUCTS AND WASTE
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
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
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
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 manufacture, 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
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 the basics of by-products generated in various food processing industries
CO2 know the importance of wastes generated and the methods to dispose or to treat the wastes
CO3 familiarise with the concepts of conversion of waste to value added products
CO4 Analyze about livestock and poultry, fish, meat processing industries, Spice processing industries etc.
CO5 Differentiate between solid waste management and its disposal

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FD3012 FLAVOUR TECHNOLOGY

OBJECTIVE
The course aims to describe manufacturing procedures used to produce the common food flavouring materials and understand the 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, chemesthesia 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 ethylmaltol, cyclic enolones.

UNIT III  PROCESS FLAVOURS  9
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, deepfat 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
CO1 understand the various mechanisms of flavour formation and flavour release
CO2 explain metabolic routes leading to flavour formation in plants
CO3 Recognize off-flavour defects in foods and strategies of identification.
CO4 Review sample preparation techniques and aroma isolation methods for food analysis.
CO5 Understand the legislation and regulations related to flavouring substances in food products.

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

UNIT I  IMPORTANCE OF MICRONUTRIENTS AND BIOACTIVECOMPONENTS  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 foraged persons, design consideration, ingredients for geriatric foods.

UNIT II  FOOD FORTIFICATION  9
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  9

UNIT IV  FOOD FOR DISEASE CONTROL  9
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, organosulphur 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  9
Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classed 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 synbiotics.

OUTCOME
At the end of the course the students will be able to
CO1  gain knowledge on nutraceuticals and functional foods.
CO2  learn about food fortification and its application.
CO3  describe and demonstrate the role of food in nutritional well being.
CO4  understanding of the diverse classes of phytochemicals and their significance in promoting health, preventing diseases, and enhancing the immune system,
CO5  understand the level of safety of functional foods

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FD3013 FOOD LEGISLATION AND STANDARDS L T P C 3 0 0 3

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


Intellectual Property and Food Labelling: Trademarks and Geographical Indications, Agricultural Innovation: Patenting and Plant Variety Rights Protection, Cross- Contamination, Genetic Drift, and GMO Co-existence with Non-GM Crops, Legal Barriers to International Food Trade, food policies

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** Food product categorization, Use of food additives in different products

**CO3** assess the meaning of what is Intellectual Property and Food Labelling: Trademarks and Geographical Indications

**CO4** understand about , Pesticides and Cancer in Conventionally-Grown Versus OrganicFood

**CO5** understand about Cooperatives and Producer Organizations Roles in AchievingFood Security

**REFERENCE BOOKS**


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**FD3014** **CONTROL OF FOOD INFESTATIONS**

**OBJECTIVE**
The course aims to develop the knowledge about pest infestation and its associated risk and enable students to understand the methods involved in prevention an control of pests.

**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; buildingdesign 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 have awareness about post-harvest issues in stored grains and processed foods caused by pests

CO2 improve the analysing and problem-solving capabilities on risk assessments and prevention and control of pests.

CO3 learn the importance of pest management and its regulatory aspects.

CO4 Understand about warehousing and storage areas

CO5 Analyze about Regulatory aspects of pest management

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

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OBJECTIVE

- To enlighten the students with the various steps involved in start-up of the food industry.
- To inculcate students with management skills that’s 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 land collection and Chilling center. Space requirement.

UNIT II  PREPARATION OF A PLANT LAYOUT


UNIT III  PRACTICAL ASPECTS OF DESIGNING PLANT LAYOUT

Siting of Process sections, Equipment selection and capacity determination, Arrangement of

UNIT IV LICENSING AND REGISTRATION 9
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 9
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.

OUTCOME
At the end of the course the students will be able to
CO1 apply their knowledge on development and management of food industries.
CO2 have knowledge on registration and obtaining license from FSSAI.
CO3 have knowledge on raising funds from different agencies to establish the plant.
CO4 Understand about FSSAI regulations.
CO5 Analyze Technology development funds

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TOTAL: 45 PERIODS

FD3016 ADVANCED INSTRUMENTATION FOR FOOD SAFETY AND QUALITY

OBJECTIVE
Objectives: To gain insight into the state-of-art techniques in food quality analysis

UNIT I HPLC ANALYSIS OF FOOD 9
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 carrygases 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

UNIT IV   NON DESTRUCTIVE TECHNIQUES IN FOOD ANALYSIS
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
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.

OUTCOME
CO 1 To demonstrate, analyze, construct and assess quality of food using HPLC
CO 2 To demonstrate, analyze, construct and assess quality of food using GCMS
CO 3 To demonstrate, analyze, construct and assess quality of food using LCMS
CO 4 To demonstrate, analyze, construct and assess quality of food using Non-destructive techniques
CO 5 To demonstrate, construct microbial analytical techniques.

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

TOTAL: 45 PERIODS
FD3017 FOOD SAFETY AND RISK ANALYSIS

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.

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 Analyze about Risk Analysis at International and National Levels.
CO3 Differentiate about the development of company certification, product
standardization, contribution to product traceability.

**CO4** Familiarize about Biotechnology risk assessment and sensitivity analysis.

**CO5** Understanding risk communication, the goals of risk communication.

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**FD3018 BEVERAGE TECHNOLOGY**

**OBJECTIVE**

The course aims to gain knowledge 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-Teatypes- 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.

**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** List quality control steps in beverage preparation.

**CO4** Understand the different of types of tea.

**CO5** Analyze the regulations and standards related to ingredient thresholds and quality parameters.

**REFERENCE BOOKS**

**Course Articulation Matrix**

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FD3019 FOOD NUTRIGENOMICS  

**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 polygenic diseases.

**UNIT I GENE-DIET INTERACTIONS**

**UNIT II MODULATING DISEASE RISK**
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**

**UNIT IV METABOLOMICS AND COMPUTATIONAL APPROACHES**
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
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

OUTCOME
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

REFERENCE BOOKS

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FD3020  FOOD INFORMATICS

OBJECTIVE
The course aims to know the basics of bioinformatics and structural modelling of food ingredients and familiarize 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 form multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Auto Dock, NGS Data resources

TOTAL: 45 PERIODS

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 Gain knowledge about 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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OBJECTIVE
The course aims to familiarize Students with design, development and scale up of food products and understand the 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 recipes 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
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
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
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 gain knowledge on various aspects of Creativity, Innovation and New Product Development
CO2 understand the process of development of food products
CO3 develop ideas for new food products which are nutritious, cost effective, functional and marketable
CO4 Analyse about standard product and conformation to standards
CO5 Familiarize with food choice models and new product trends.

REFERENCE BOOKS
4. Side, C. “Food Product Development: Based on Experience”, Iowa State
FD3022  SENSORY ATTRIBUTES AND EVALUATION OF FOODS  

OBJECTIVE
The course aims to inculcate students with knowledge on principles and significance of the sensory perception mechanism and understand various techniques in quality and sensory analysis of food products.

UNIT I  PRINCIPLES AND SIGNIFICANCE
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 ODOR
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, odor intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste.

UNIT III  SENSORY MEASUREMENTS
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; Interehannelship between sensory properties of food products and various instrumental and physio-chemical tests.

UNIT IV  SENSORY QUALITY EVALUATIONS
Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, direction 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
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.

OUTCOME
At the end of course, student will be able to
CO1 have detailed knowledge on physiology and mechanism of human sensory perceptions.
CO2 understand sensory analysis and quality evaluations
CO3 do market analysis and evaluate customer acceptance and preferences
CO4 Gain a comprehensive understanding of the application of sensory testing in foodproduct development and quality control
CO5 Understand the factors that influence acceptance and preference in consumer behaviour

REFERENCE BOOKS

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FD3023 ADVANCED FOOD MICROBIAL ANALYSIS

OBJECTIVE
The course aims to gain knowledge on significance of microbial metabolism in food and understand the 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

53
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

CO1 Understand the microbiological aspects of fresh and fermented foods,

CO2 Gain knowledge about microbial metabolism and its interactions with the food matrix

CO3 Analyse different methods of bacterial identification, including morphological, physiological, biochemical, immunological.

CO4 Applications of food microbiology, such as the beneficial uses of bacteria in food, probiotics, prebiotics, synbiotics.

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

REFERENCE BOOKS


3. Osman erkmen, T. faruk Bozoglu, “Food microbiology” John Wiley and sons, 1st


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FD3024 APPLICATIONS OF ENZYMES IN FOOD INDUSTRY

OBJECTIVE

The course aims to develop an understanding on enzymes used in food product development and understand the 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, pectinases, 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; xylanses and pentosanases 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 (likesurimi 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
CO1 list different enzymes applied in processing of foods
CO2 understand the applications of enzymes in the production of various plant and animal products in food industries
CO3 have better understanding of role of enzymes in the production of food additives and novel applications on food packaging as sensors
CO4 Understand the role of enzymes as additives in the food industry, including their use as antioxidants or antimicrobial agents
CO5 knowledge about the use of enzymes in active packaging and edible coatings and films

TOTAL: 45 PERIODS

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FD3025  NANOTECHNOLOGY IN FOOD APPLICATIONS  L  T  P  C
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OBJECTIVE
The course aims to expose the students in the advanced knowledge in nanotechnology and enable Students understand the use of nanotechnology in processing and packaging of foods

UNIT I  NANOPARTICLES- INTRODUCTION AND PREPARATION  9

UNIT II  CHARACTERIZATION TECHNIQUES  9
X-ray diffraction technique, Scanning electron microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysisttechniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT III  NANOTECHNOLOGY IN FOOD PROCESSING  9

UNIT IV  NANOPACKAGING  9
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 offoods

UNIT V  NANO SENSORS  9
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 understand different methods for preparation and characterization of important properties of nanomaterials, commonly used in food sector
CO2 understand nanoparticles applications in different food technology operations like processing & packaging
CO3 gain knowledge on food safety components using nanomaterials
CO4 Analyze about the Potential of nanomaterials in food packaging like Nano polymers, Nanocomposites, Nanolaminates
CO5 Familiarize with Regulatory Framework for Food Nanotechnology

REFERENCE BOOKS

56
FD3026 GENETIC ENGINEERING AND GENETICALLY MODIFIED FOODS

OBJECTIVE
Introduction to GM foods and their methods of production, advantages
To study genetically modified plants which are commercially available, study transgenic animals and their engineering method and understand genetically modified microorganisms and 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 bacteriophage, 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, AFLPPCR, 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 rDNA TECHNOLOGY IN FOODS
Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria: ChymosinLight 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 would have the knowledge to
1. Better understanding of genetically modified plants, animals and modified microorganisms
2. Familiarize in Pharmaceutical applications of genetically engineered plants
3. Obtain knowledge in Risk and safety assessment of the GM foods and their label.
4. Apply the genetically modified microorganisms and their applications in foods understand Risk and safety assessment of the GM foods and their labeling
5. Understand the applications of genetically engineered organisms and rDNA technology in foods.
REFERENCE BOOKS

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FD3027 FOOD STRUCTURING TECHNIQUES

OBJECTIVE
The course aims to
• Introduce the techniques of developing structured food products. Evaluate 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 would have the knowledge to

- Aware techniques of developing structured food products.
- Understand the concepts and principles of food structuring.
- Assimilate the modern techniques of food structure development.
- Evaluate the technical and functional performance of structured food materials.
- Familiarize with Developing Food Structure for Mechanical Performance

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FD3028 FOOD SUPPLY CHAIN MANAGEMENT

OBJECTIVE
This course aims to make students understand the 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

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

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

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

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

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 equality management during supply chain
CO5 Analyze and improve supply chain system in food sector

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FD3029 INVENTORY MANAGEMENT

OBJECTIVE

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

UNIT I INTRODUCTION TO INVENTORY MANAGEMENT

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

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
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

UNIT V ERP IN INVENTORY MANAGEMENT

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. Application of different methods and practices to address inventory management problems.

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