DEPARTMENT OF FOOD ENGINEERING AND TECHNOLOGY

M.Tech. (1st Semester) Syllabus

Sl. No.	Course Code	Course Title	Hours per week			Contact hour	Credits
			L	T	P		
1	MFE101	Research Methodology and IPR	2	2	0	4	4
2	MFE102	Recent Trends in Food Engineering and Technology	2	2	0	4	4
3	MFE103	Recent Advances in Enzyme and Microbial Technology	1	2	0	3	3
4	MFE104	Food Product Development and Entrepreneurship	3	0	0	3	3
5	MFE111*	Elective-I	3	0	0	3	3
6	MFE112*	Elective-II	3	0	0	3	3
Total			**14**	**6**	**0**	**20**	**20**

Elective-I (MFE111*)

Course Codes	Course Name
MFE1111	Modern Fruits and Vegetables Processing Techniques
MFE1112	Refrigeration and Cold Chain Management
MFE1113	Technology of Food Flavors and Spices
MFE1114	Instrumental Analytical Techniques

Elective-II (MFE112*)

Course Codes	Course Name
MFE1121	Food Biotechnology
MFE1122	Functional Food and Nutraceuticals
MFE1123	Modern Separation and Purification Technologies in Food Processing
MFE1124	Advanced Food Process Equipment and Design
MFE1125	Recent Trends in Muscle Foods and Poultry Processing

DETAILED SYLLABUS

Subject: Research Methodology and IPR

Subject Code: MFE101
Credit: 04
L-T-P: 2-2-0

Syllabus Contents:

UNIT-I: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope, and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, data analysis, interpretation

UNIT-II: Effective literature studies approaches, analysis. Plagiarism and Research ethics, Effective technical writing, how to write a report, a paper? Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-III: Overview of Intellectual Property; introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR in abroad**,** International cooperation on Intellectual Property, Licensing and transfer of technology.

UNIT-IV: Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions? Granting of patent Rights of a patent, searching a patent, Drafting of a patent, Filing of a patent, The different layers of the international patent system (national, regional and international options), Patents, Designs, Trade and Copyright.

References:

- T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000
- Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006
- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007

Subject: RECENT TRENDS IN FOOD ENGINEERING & TECHNOLOGY

Subject Code: MFE102
Credit: 04
L-T-P: 2-2-0

Syllabus Contents:

UNIT-I: Recent advances in Food Technology on different Techniques of food preservation including thermal processing- canning, pasteurization, sterilization. Design of various sterilizes for food processing, aseptic sterilization, Plate heat exchanger, Evaluation of process time in canning.

UNIT-II: Design of storage units, freezing system in food, slow and quick-freezing, Different freezes used in food industry including cryogenic freezing system. Modified Atmospheric Packaging (MAP) and Controlled Atmosphere Storage (CAS) systems. Basics of hurdle technology – Mechanism, Application to foods, Newer Chemical and Biochemical hurdles

UNIT-III: Food flavour and flavour evaluation, Colour of Food and colour measurement, Rheological properties of foods, Modern design used in food industry including freeze drying, spray drying, Microwave processing of food, Extrusion technology-single &twin-screw system.

UNIT-IV: Supercritical fluid extraction (SCFE/SFE) technology. Freeze concentration, Homogenization, Membrane separation process, Reverse osmosis, Purification of component by crystallization, filtration, and centrifugation. Modern techniques of food processing and quality control

References:

1. *Novel Food Processing Technologies* (Food Science and Technology Series) (2004). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. PilarCano, Publisher: CRC Press,
2. *Hand Book of Microwave Technology for Food Applications*. (1999). Dutta AK & Anantheswaran RC.1999.
3. *Hurdle Technologies – Combination treatments for food stability safety and quality*, (2002). Leistner L. and Gould G. Kluwer Academics / Plenum Publishers, New York
4. *New Methods of Food Preservation*, (2000) Gould GW. CRC.
5. *Trends in Food Engineering*, (2000). Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press.

Subject: RECENT ADVANCES IN ENZYME AND MICROBIAL TECHNOLOGY

Subject Code: MFE103
Credit: 03
L-T-P: 1-2-0

Syllabus Contents:

UNIT-I: Morphology and physiology of industrial microorganisms (Bacteria, yeasts, molds and actinomycetes). Isolation, identification and quantitative estimation of microorganisms, Microbiological assay, Genetics of some industrial microorganisms, Microbiology of soil, Selection, development, and maintenance of cultures.

UNIT-II: Large scale production and purification of biomolecules. Application of biocatalysts for new reactions and organic synthesis. (Immobilised enzymes and synzymes –Application in organic synthesis). Immobilisation of living microbial cells and transformation of steroids. Enzyme kinetics and mass transfer or two liquid phase, Heterogeneous systems. New immobilisation techniques of biomaterials and their application.

UNIT-III: Industrial applications of immobilised biomaterials. Biomass conversion with energy production, Analytical application of immobilised enzymes. Recent studies on Antibiotics and low molecular weight Enzyme inhibitor. Recent development and future aspects of enzyme Engineering.

UNIT-IV: Chemistry and biosynthesis of microbial products e.g. vitamins, amino acids, enzymes, steroids, antibiotics, and polymers. Metabolic regulations in industrial fermentation. Microbial transformation of alkanes, alkaloids, terpenes, aromatic compounds and naturally occurring polymers. Microbial food production. Spoilage microorganisms in foods and their control. Mycotoxins and Microbial insecticides.

References:

1. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry text books by Stryer, Voet and Lehninger (Relevant Chapters)
4. Fermentation Microbiology and Biotechnology, Second Edition by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A.R. Allman
5. Principles of Fermentation Technology by P F Stanbury, A Whitaker, S Hall,

Subject: FOOD PRODUCT DEVELOPMENT AND ENTREPRENEURSHIP

Subject Code: MFE104
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Introduction to food product development, need, importance and objectives of product development in food industry; factors affecting food product development- extrinsic and intrinsic; steps in food product development; methodology involved in food product development; Concept Development: context and planning, frameworks for understanding customer needs, Concept generation, Translating the voice of the customer, Concept Selection, Concept testing overview.

UNIT-II: Food laws in food product development; process control parameters and scale up of developed products, market testing and marketing plans for developed products, costing and economic evaluation of developed products. Customer and user need assessment, market research- prototype development – market testing – feedback- commercial production- feedback- improvement.

UNIT-III: An Overview and Key Concepts of Project Management, Project planning & Project Feasibility Studies.DPR preparation for the project. Structures & techniques adopted by Project Management Institute (PMI). Human Aspects in Project Management, Project Scheduling with PERT/CPM, contingencies arrangement or plan 'B' preparation. Time-Cost-Trade-Off and Crashing of Projects. Human Resources Management.

UNIT-VI: Introduction to entrepreneurship: History, evolution and definitions of entrepreneurship, entrepreneur, entrepreneurial characteristics; Sequential stages of development of an entrepreneurship – Case studies; Definitions and classification of large, medium and small scale business. Trade license and registration; Selection of land for business and/or industries. Source of finance(s); Sources of machine(s) and equipment(s); Agencies for business promotion for food processing industries. Project report, market feasibility report, techno-economic feasibility report on food businesses

References:

1. Accelerating New Food Product Design and Development- Backley, 2007, Blackwell publishing, Oxford, UK.
2. Sensory and Consumer Research in Food Product Design and development- Moskowitz, 2006, Blackwell publishing, Oxford, UK.

Elective-I (MFE111*) Subjects

CODE	SUBJECTS
MFE1111	Modern Fruits & Vegetables Processing Techniques
MFE1112	Refrigeration and Cold Chain Management
MFE1113	Technology of Food Flavors and Spices
MFE1114	Instrumentation and Analytical Techniques

Subject: MODERN FRUITS & VEGETABLES PROCESSING TECHNIQUES

Subject Code: MFE1111
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Principles and methods of fruit and vegetable preservation. Advanced techniques for fruits and vegetables preservation. Low cost methods of preservation. Use of additives in product development. Enzyme and its application in fruits and vegetables processing, Ripening of fruits and role of enzyme.

UNIT-II: Measurement of colour, texture and other physico-chemical characteristics of fruits and vegetables. Characterisation of fruit flavour, retention of flavour. Analyses and detection of contaminants and adulterants, Microbiology of fresh and processed products and its control.

UNIT-III: Fruit and vegetable juices, preparation of syrups, cordials and nectars, juice concentrates, pectin and related compounds, jams, jellies, marmalades, preserves, theory of gel formation. Pickles, chutneys and vinegar production, tomato products.

UNIT-IV: Fruits and Vegetables processing equipments, Factory sanitation and hygiene. Legislation of processed fruit and vegetable products. Utilisation of fruits and vegetables processing waste.

References:

1. Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, *Novel Food Processing Technologies*, CRC Press, 2005
2. Rachna Sehrawat, Khursheed A. Khan, Megh R. Goyal, Prodyut K. Paul, Technological Interventions in the Processing of Fruits and Vegetables
3. Özlem Tokuşoğlu, Barry G. Swanson, Improving Food Quality with Novel Food Processing Technologies

Subject: REFRIGERATION AND COLD CHAIN MANAGEMENT

Subject Code: MFE1112
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, Ozone Depletion Potentials, Green house Potential Refrigerants, use of non polluting refrigerants

UNIT-II: Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapor barriers, care and maintenance of cold storage, Cold Storage practices, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

UNIT-III: Frozen storage and temperatures, insulation of freezer rooms: Freezing rates, ice crystal growth, crystal size and its effect on texture and quality of foods, Freezing equipment; Freezer types, Blast freezers, Contact Plate Freezers, conveyorized quick freezers, Individual quick freezing. Cryogenic Freezing, Freezing practice for meat, poultry, fruits, and vegetables

UNIT-IV: Cold chain system - Important Factors to consider, logistic supply- Protocols for Domestic, Sea and Airfreight; Product Temperature and Moisture monitoring, transportation via land, air and sea, Grocery stores and display cases, Storage and packaging

References:

1. Anand, M.L. “Refrigeration and Air-conditioning”, Asian Books,
2. Clive D.J. Dellino: Cold and Chilled Storage Technology Publisher: Kluwer Academic Publishers
3. Andrew D Althouse and others: Refrigeration and air Conditioning Goodheart – Willcox Company Inc. 1982
4. E.R. Hollowell: Cold Storage and Freezer Storage Manual AVI Publishing Co.
5. Aurel Gobaneu and Gabriala Laseha and others (1976) Cooling Technology in the Food Industry: Abacus Press, Tunbridge Wells, U.K.
6. Dellino, C.V.J “Cold and Chilled Storage Technology”, Chapman Hall India

Subject: TECHNOLOGY OF FOOD FLAVORS AND SPICES

Subject Code: MFE1113
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Introduction to flavor and flavor profile. Natural and synthetic flavoring substances and their chemical characteristics. Olfactory perception of flavor- Classification of flavors, Flavor potentiators, Flavor components/constituents of fruit and vegetables, coffee, tea and cocoa bean, spices and condiments, Measurement of flavor

UNIT-II: Effect of storage, cooking condition, processing, transportation, and environmental condition on flavor components. Extraction, isolation, and characterization of flavoring compounds of plant sources, and their utilization and application in food industries; Recent developments in flavor research, processing, and technology

UNIT-III: Total component analysis; methods, recent developments. Head space analysis; static and dynamic methods, basic principles, method and developments, Solid phase micro extraction of aroma components; Electronic Nose (E-nose) technology.

UNIT-IV: Scope of spice processing in India, Types, qualities. Uses and physiological effects; components, antimicrobial and antioxidant properties, Medicinal value of condiments and spice products. Major spices- Pepper, cardamom, ginger, chili, and turmeric–Oleoresins and essential oils; method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavour identicals; quality control; fumigation and irradiation of spices

References:

1. *Food Flavor and Chemistry: Explorations into the 21st Century*,(2005), Spanier, A.M *et al.*,
   RSC.
2. *Food Flavours – Biology and Chemistry*, (1997). Carolyn Fisher, Thomas R. Scott, RSC Publishing
3. *Handbook of Flavor Characterization (Food Science and Technology)*, Kathryn D. Deibler, Jeannine Delwiche, Marcell Dekker Inc.
4. *Spice Science and Technology*, (1998). Hirasa, K and Takemasa, M. Marcel Dekker,
5. *Handbook on Spices*. National Institute of Industrial Research Board (NIIR), Asia Pacific Business Press Inc.

Subject: INSTRUMENTAL ANALYTICAL TECHNIQUES

Subject Code: MFE1114
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Introduction to spectroscopic techniques, UV - Vis Spectrophotometry, Turbidimetry, Reflectance Spectrometry, Fluorescence, Phosphorescence Spectrometry.

UNIT-II: Principle, Instrumentation and analytical applications of following techniques; Atomic Absorption spectroscopy , Flame photometry, Inductively coupled plasma-Atomic Emission spectroscopy, Scanning Electron Microscopy

UNIT-III: Chromatography: Gas solid Chromatography, Gas liquid Chromatography, ion exchange chromatography, paper chromatography, thin layer chromatography, column chromatography, gel permeation chromatography, High performance liquid chromatography (HPLC)

UNIT-IV: Infrared spectrometry, Introduction to X-Ray techniques, XRF, Introduction to NMR spectroscopy and mass spectrometry, Electroanalytical techniques: Potentiometry, Voltametry, Polarography.

References:

1. Principles of Instrumental Analysis, Skoog, Holler, Nieman, Saunders College Publishing.
2. Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, Wadsworth Publishing Company.

Elective-II (MFE112*) Subjects

CODE	SUBJECTS
MFE1121	Food Biotechnology
MFE1122	Functional Food and Nutraceuticals
MFE1123	Modern Separation and Purification Technologies in Food Processing
MFE1124	Advanced Food Process Equipment and Design
MFE1125	Advances in Muscle Foods and Poultry Processing

Subject: FOOD BIOTECHNOLOGY

Subject Code: MFE1121
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Advances in preservation of Food by various biotechnological processes. Technology on fermented foods for fruits, vegetables, cereals, legumes, milk, meat, fish etc. Role of lactic acid bacteria on preservation of food items.

UNIT-II: Extraction and clarification of fruit/vegetable juice by enzymes. Fermentative production of enzymes like amylase, proteases, pettiness, glucose isomers, glucose oxidazes cellulase, xylanase, lipases etc.

UNIT-III: Purification of enzymes by downstream processing. Production of alcohol, lactic acid and acetic acid from various food materials. Bacteriocin production and uses in food preservation,

UNIT-IV: Biotechnological processes for manufacture of functional foods: nutraceuticals and probiotics. Biotechnological process for food fortification, prebiotics & oligosaccharides. Improvement of quality of food by biotechnological processes. Treatment of waste from food industries by biotechnological application.

References:

1. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, Food Biotechnology, CRC press
2. Byong H. Lee, Fundamentals of Food Biotechnology, Wiley
3. Vinod K. Joshi, R. S. Singh, Food Biotechnology: Principles and Practices

Subject: FUNCTIONAL FOODS AND NUTRACEUTICALS

Subject Code: MFE1122
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-1: Introduction to Nutraceuticals as Science: Historical perspective, classification, scope & future prospects. Sources of Nutraceuticals. Properties, structure and functions of various Nutraceuticals: Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate. Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals. Role of Probiotics and Prebiotics as nutraceuticals

UNIT-II: Food as remedies: Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Liver disorders, Osteoporosis, Psoriasis, Ulcers, obesity, immune enhancement, age-related macular degeneration, endurance performance and mood disorder etc.

UNIT-III: Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues. Anti-nutritional Factors present in Foods

UNIT-IV: Functional foods, vitamin- and mineral-enriched products, products containing added fibre, and omega-3 fatty acids/oils. Fortified beverages with calcium or omega-3 oils, yogurts with probiotics and drinks with herb blends as well as omega-3 eggs.

References:

1. Rotimi E. Aluko, Functional Foods and Nutraceuticals, Springer
2. R.C. Wildman, Handbook of Nutraceuticals and Functional Foods, CRC Press

Subject: MODERN SEPARATION AND PURIFICATION TECHNOLOGIES INFOOD PROCESSING

Subject Code: MFE1123
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Introduction: Separation process in chemical and Biochemical industries, Categorization of separation process, equilibrium, and rate governed processes.

UNIT-II: Modern separation techniques e.g. Membrane based separation technique (MBSTs): Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Membrane separation, supercritical extraction, liquid membrane,

UNIT-III: Osmosis and osmotic pressure. Working principle, operation and design of reverse osmosis, ultrafiltration, microfiltration, electrodialysis and pervaporation. Gaseous separation by membranes.

UNIT-IV: Ion Exchange: Basic principle and mechanism of separation, Ion exchange resins, regeneration and exchange capacity. Exchange equilibrium, affinity, selectivity and kinetics of ion exchange. Design of ion exchange systems and their uses in removal of ionic impurities from effluents. Introduction to foam separation, Ion-exchange foam separation, micellar separation, liquid membrane permeation and chromatographic separation.

References:

1. King, C. J. Separation Processes, (Tata McGraw-Hill)
2. Sourirajan, S. and Matsura, T. Reverse Osmosis and Ultra-filtration – Process Principles
3. Porter, M. C. Handbook of Industrial Membrane Technology, (Noyes Publication)
4. Hatton, T. A., Scamehorn, J. F. and Harvell, J. H. Surfactant Based Separation Processes, (Marcel Dekker Inc.)

Subject: ADVANCED FOOD PROCESS EQUIPMENT AND DESIGN

Subject Code: MFE1124
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Machine Design: Introduction to equipment or machine design, Basic requirements for machine elements and machines, classification of engineering materials, selection of materials for engineering purposes, mechanical properties of metals, Manufacturing considerations in machine design; introduction to load, stress, strain, Young Modulus of Elasticity or Stress modulus or Modulus of rigidity, Stress strain diagram, Factor of safety, Theories of failure under static load, Corrosion mechanism and its control.

UNIT-II: Riveted Joints: Introduction Riveted points, kinds of riveted joints, failures of riveted joints, strength of riveted joint, Riveted value, efficiency of riveted joint, assumption for design of riveted joint, Design of riveted joint, Numerical problems. **Welded Joints**: Introduction to welding, advantages of welded joints over riveted joints, disadvantages of welding joints, classification of welding processes, types of welded joints, strength of welded joints, numerical problems. **Shafts, Keys & Coupling**: Different types of shafts, failures in shafts, design of strength shafts and axels, Types of keys, strength of keys, types of shafts coupling & their designs

UNIT-III: Heat Exchangers: Concept of overall heat transfer coefficient, LMTD, efficiency of parallel and counter current flow heat exchanger, design of double pipe heat exchanger, design of hair pin heat exchanger, multitude finned inner tubes, design of shell and tube heat exchanger

UNIT-IV: Design of Pipes: Different types of pipes, fabrication method of different types of pipes, testing of piping material, colour codes, different types of piping pints, different types of flow regulators)

References:

1. M V Joshi, Process equipment design
2. DR Heldman and R P Singh : Food Engineering and Operations
3. R C Sachdeva: Fundamentals of Engg. Heat and Mass Transfer.

Subject: ADVANCES IN MUSCLE FOODS AND POULTRY PROCESSING

Subject Code: MFE1125
Credit: 03
L-T-P: 3-0-0

Syllabus Contents:

UNIT-I: Composition, classification, and color of meat, slaughtering techniques, meat cuts, Nutritional value of meat, Meat microbiology and safety, Post mortem changes in meat; Conversion of muscle to meat; Freshness and quality assessment of raw and processed meat

UNIT-II: Meat and poultry processing- curing and smoking; Fermented meat products (sausages and sauces); Frozen meat & meat storage. Beef Mutton, Pork Sausages and other meat products, Meat plant hygiene – GMP and HACCP, Byproduct utilization in meat and poultry processing

UNIT-III: Nutritional and Functional characteristics of Egg. Manufacturing of egg white, Egg yolk and Whole Egg solids/powder.

UNIT-IV: Classification of fresh water fish and marine fish; Commercial handling, storage and transport of raw fish. Methods of processing and preservation of fish- Canning, Freezing, Drying, Smoking and Curing. Fish products – fish meal, fish protein concentrate etc.

References:

1. R. A. Lawrie, Lawrie's Meat Science, Woodhead Publishing Limited
2. Y. H. Hui, Wai-Kit Nip, Robert Rogers, Meat Science and Applications, CRC Press