- M. Tech in Food Technology (**Food Engineering**)

Basic Supporting Courses:

	Course Code	Course Title	L	T	P	Credit
1.	COMP 805	Computer Programming	2	0	1	3
2.	MAS 713	Advanced Engg. Statistics	3	0	0	3
3.	APFE 705	Optimization Techniques in Food Technology	3	0	0	3
4.	CHEM 717	Advanced Food Chemistry	2	0	1	3

Core Courses:

	Course Code	Course Title	L	T	P	Credit
1.	APFE 706	International Food Legislations & Standards	2	0	0	2
2.	APFE 707	Food Quality Control	2	0	1	3
3.	APFE 708	Meat & Marine Technology	2	0	1	3
4.	APFE 802	Modern Fruits & Vegetables Processing Techniques	2	0	1	3
5.	APFE 803	Advanced Food Packaging	2	0	0	2
6.	APFE 811	Advanced Beverage Technology	3	0	0	3
7.	APFE 823	Modern Baking & Confectionary Technology	2	0	1	3
8.	DT 820	Processing of Milk & Milk Products	2	0	1	3
9.	MBMT811	Food Microbiology	2	0	2	4

Specialized Courses:

Food Engineering:

Course Code	Course Title	L	T	P	Credit
APFE 801	Advanced Food Process Equipment Design	3	0	0	3
APFE 810	Food Plant Design	3	0	0	3
APFE 817	Food Process Modeling	2	0	0	2
APFE 825	Rheology & Texture Analysis	2	0	1	3
APFE 826	Food Production Technology	3	0	0	3
APFE 827	Transport Phenomenon in Food Processing	3	0	0	3
APFE 828	Food Process Management & Control	3	0	0	3
APFE 829	Simulation of flow patterns in Food Process Equipment	2	0	0	2

Basic Supporting Courses:

COMP 805   Computer Programming 3(2-0-1)

Algorithms & Flow Charts, C. Programming, Preliminaries, Constant & Variables, Arithmetic Expressions Input-Output Statements, Control Statements, Do-Statements, Subscripted Variables, Elementary Format Specifications, Logical Statement & Decision Tables, Functions & Subroutines, Arrays & structure, Computer Oriented Numerical Methods, Solution of Non Linear Equation. Bisection Method, Newton Method, Numerical Integration, Trapezoidal Method, Simpson's 1/3 & 3/8 rule, Curve Fitting, Construction of forward, backward, backward difference table, Interpolation, Application of Statistical packages.

MAS 713   Advanced Engineering Statistics 3(3-0-0)

Sample size, data collection, design of experiments, LSD, RBD, split plot design, factorial design, CRD, CCRD, testing of hypothesis, Analysis of variance, t-test, z-test, f-test, X^2-test.

APFE 705 Optimization Techniques in Food Technology 3 (3-0-0)

Principles of modelling; Linear programming-concepts, graphical and algebraic solution; Simplex method; Duality theory; Post-optimality analysis; Sensitivity analysis; Transportation and assignment models; Computer applications to LP, queuing theory; Project scheduling and management by PERT-CPM; Integer programming; Non-linear programming; Simulation; Goal programming; Decision theory; Markov chains; Sequencing problem.

CHEM 717   Advanced Food Chemistry 3(2-0-1)

Water:- Water binding and chemical mediated water.Food protein: Classification, physico-chemical properties. Reactions involved in processing. Reactions with alkali. Enzyme catalyzed reactions involving hydrolysis and proteolysis. . theories of formation of texturiesed proteins.
Lipids :- Reactions involved during deep frying of foods viz., autoxidantion of saturated acyl lipids and polymerization. Lipopotein and membrane; definition, classification and involvement in the formation of biological membrane. Unsaponsifiable matter contents in various fats and oils. Edible oil classification and chemical composition.
Carbohydrates:- Legumes jam and jellies polysaccharide. Viz., liner, branched and modified. Properties and utilization of common polysaccharides, viz. Cellulose, glycogen, hemicellulose and pectin. Enzymatic degradation of polysaccharides, viz. agar, alginate, carrageenam, gums and starch. Production of dextrans and malto dextran.
Food Enzymes:- Hydrolases and lipases, utilization in food industry, effect of inhibitors, pH and temperature.
Minerals in food :- Main elements, trace elements in eggs, cereal and cereal products vegetables and fruits.
Aroma compounds in foods:- Threshold value, off flavours.
Food additives:- Vitamins, amino acids, minerals, Aroma substance flavour enhancers-monsodium glutamate, 5-nucleotides. Sugar substitutes, sorbital. Sweeteners-saccharin, cyclamate. Food colour. Anti-nutritional factors and food contaminant: Toxic-trace elements, radio nuclides.
Cereals and cereal products:- Individual constituents, like proteins, lipids carbohydrates and vitamins in cereals flour and their relationship in dough making. Types of flours, bread making and non-bread making chemical composition influence of additives/minor ingredients on baking properties.
Legumes:-Classification composition and physio-chemical properties.

Vegetables and fruit: Classification general composition, chemical changes during ripening and storage. Jams, jellies and pickles: Classification, composition and preservation.
Beverages: Classification, coffee, tea and cocoa-gradation, composition, chemical changes during processing, volatile compounds. Preservation of foods: General principles of food preservation, chemical preservation, preservation through irradiation.

Core Courses

APFE 706 International food Legislation & Standards   2 (2-0-0)
Concepts and trends in food legislation. International and federal standards: Codex alimentarious, ISO series, food safety in USA. Legislation in Europe: Directives of the official journal of the EU, council regulations, food legislation in UK. Regulating methods for food analysis, case studies. Enforcers of Food Laws Approval Process for Food Additives Nutritional Labeling.

APFE 707 Food Quality Control   3(2-0-1)
Quality factos: appearance, texture and flavor, Apperance factors – size and shape, colour ad gloss, consistency. Textural Factors – measuring texture, texture changes. Flavour Factors – influence of colour and texture on flavor. Taste Panels. Food – related azards – biological hazards, chemical hazards, physical hazards, trace chemicals. Microbiological considerations in food safety. Food additives – preservatives, atioxidats, sequestrants, surface active agents, stabilizers and thickeners, bleaching and maturing agents, starch modifies, buffers, acids, alkalis, food colours, artificial sweteners, nutritional additives, flavouring agents. Food laws: Federal Food Drug and Cosmetic Act (1938), Good Manufacturing Practices (Code of GMP), Fair Packaging and Labeling Act (1966), Federal Meat Inspection Act (1906), International Food, Standards and Codex Alimentarius, HACCP and ISO 9000 series.

APFE 708 Meat & Marine Technology   3(2-0-1)
Sources of meat and meat products in India, its importance in national economy. Chemical composition and microscopic structure of meat. Effect of feed, breed and management on meat production and quality. Slaughtering of animals and poultry, inspection and grading of meat. Factors affecting post-mortem changes, properties and shelf-life of meat. Meat quality evaluation. Mechanical deboning, meat tenderization. Aging, pickling and smoking of meat. Meat plant sanitation and safety, Byproduct
utilization. Recent trends in meat processing. Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Factor affecting egg quality and measures of egg quality. Types offish, composition, structure, post-mortem changes in fish. Handling of fresh water fish. Canning, smoking, freezing and dehydration of fish. Fish sausage and home making. MMPO, MFPO, radiation processing meat safety.
Practical: Slaughtering and dressing of meat animals, Study of post-mortem changes, Meat cutting and handling, Evaluation of meat quality. Experiments in dehydration, freezing, canning, curing, smoking and pickling offish and meat, Shelf-life studies on processed meat products, Evaluation of quality and grading of eggs, Preservation of shell eggs, Estimation of meat: bone ratios, Preparation of meat products, canned, dehydrated, barbecued sausages, loaves, burger, fish finger.

APFE 802 Modern Fruits and Vegetables Processing Techniques   3(2-0-1)
Principles and methods of fruit and vegetable preservation. Composition and related quality factors for processing. Principles of storage of fruits and vegetables. Types of storate: natural, ventilated low temperature storate, DA and MA storages. Preservation of fruits and vegetables by

heat, chemicals, sugar, salt, fermentation, drying etc. Canning of fruits and vegetables, tin cans, glass containers seaming technology, aseptic canning technology. Fruit and vegetable juices, preparation of syrups, cordials and nectars, juice concentrates, pectin and related compounds, jams, jellies, marmalades, preserves. Theory of gel formation, quality control, pickles, chutneys and vinegar production, tomato products. Drying and dehydration of fruits and vegetables, problems related to storage of dehydrated products. Freezing and freeze-drying of food and frozen products, Fruit product order and quality control.

Practicals: Equipment for fruits and vegetable processing, plant-layout, can seaming operation, preparation of fruit juices, squashes, syrups and ready-to-serve beverages. Canning of fruits and vegetables. Preparation of jams, jellies, marmalade, preserves, and candies. Preparation of pickles, chutneys, and tomato products, Drying of fruits and vegetables, quality control of processed products. Visit to fruit and vegetables processing factories, freezing of foods, Processing of mushroom.

APFE 803 Advanced Food Packaging   **2(2-0-0)**

Introduction to principals of Food Packaging, Types of packaging , Special packaging methods (vacuum, gas and shrink packaging), Function of a package, packaging materials, their structural qualities and performance including moisture and gas transmission, interaction of food and the packaging material, methods of package testing, performance evaluation and design of packaging systems for plant and animals products. Food packaging and law, shelf life testing, modern and traditional packaging material, physical and chemical properties, production, storage and recycling of packaging materials, regulation and equipment analysis of various existing packaging system and standards.

APFE 811   Advanced Beverage Technology   **3(3-0-0)**

Introduction: classification, production and consumption f beverages. Alcoholic beverages: concept of fermentation for production of beer, wine and distilled beverages including their packaging and maturation. Non-alcoholic beverages: carbonated and non-carbonated. Raw materials, equipment, quality control and legislation of beverage products. Mini-projects on traditional production of beverages.

APFE 823   Modern Baking & Confectionary Technology   **3(2-0-1)**

Introduction: Status of bakery and confectionery industries in India- Raw materials for bakery and confectionery products-Essential and optional. PFA Specification of raw materials. Bakery products technology: Dough rheology – Bread making- methods- process- specification for various types of breads- Biscuit manufacturing process- Cookies- Crackers- Cakes- Buns- preservation of bakery products. Bakery machinery and equipment: Weighing Equipment- Manual scale, Automatic weigh, liquid measuring. Mixing- blenders, Horizontal and vertical planetary, continuous. Make up equipment- Divider, Rounder, Proofer, moulder. Baking equipment – different oven, slicer.

Confectionery products: chocolate, fondant, caramels, fudge and toffee. Equipment and process. Safety and sanitation: Health and safety- safety rules- safe practices in the work places- sanitation- duties of the sanitation equipments- Code for hygiene condition in bakery and biscuit manufacturing unit.

DT 820 Processing of Milk and Milk Products   3(2-0-1)

Sources, and composition of milk, processing of market milk, standardization, toning of milk, homogenization, pasteurization, sterilization, storage, transportation and distribution of milk. Milk product processing-cream, butter, , condensed milk, evaporated milk, whole and skimmed milk powder. Instantization of milk and milk products, ice cream, khoa, channa, paneer, milk sweets. Judging and grading of milk and its products. Fermented milk products. cheese, cheese spread, Youghurt, dahi shrikhand and similar products. Dairy equipments and sanitization.

MBMT 811   Food Microbiology   4(2-0-2)

History of microbiology of food. Microbial growth pattern, physical and chemical factors influencing destruction of micro-organisms. Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products and their control. Contaminants of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, microbial food fermentation, standards for different foods. Food borne intoxicants and mycotoxins.

Practicals : Microscopy and micrometry. Preparation of nutrient media, sterilization and inoculation techniques, Isolation of pure culture, microbial examination of natural food products, identification of food pathogen in water, milk, cereals, pulses, oilseeds, meat and poultry. Microbial production of alcohol (cereal based), acetic acid and lactic acid.

Specialized Courses

APFE 801   Advanced Food Process Equipment Design   3(3-0-0)

Design considerations of agricultural and food Processing Equipments. Design of Food Processing equipments, Dryers, design of dryers PHTC, RPEC, LSU and Drum Dryer. Determination of heat and air requirement for drying grains. Types of heat exchanger. Design of heat Exchangers and Evaporators. Design of material handling equipments like belt conveyor, screw conveyor, bucket elevator and pneumatic conveyors.

APFE 810   Food Plant Design   3(3-0-0)

Food Plant Location, Food Plant Layout, Process Selection, Forecasting methods, Facilities & Aggregate Planning, Scheduling Food Plant Operations, Financial Analysis, Process Flow Analysis, PERT/CPM Models, Decision Analysis, Computer Simulation, Feasibility Studies of Food Plant; Design of a Food Processing Plant.

APFE 817   Food Process Modelling   3(3-0-0)

The principles of Modelling, kinetic Modelling, the Modelling of heat and mass transfer; introduction diffusion equation, the Navier-stokes equations, heat and mass transfer in porous media Luikov's equation. Modelling thermal processes: cooling and freezing, introduction Modelling product heat load during cooling & freezing. Modelling foods with

complex shapes, numerical solution of the heat conduction equation with phase change. Modelling thermal processes : heating, introduction, processing of packed and solid foods, continuous heating and cooling processes, Modelling food quality and microbiological safety.

APFE 825 Rheology and Texture Analysis   3(2-0-1)

Texture classification. Relation of food texture with structure and rheology. Principles and practices of objective texture measurements, viscosity measurements. Sensory methods of texture and viscosity measurements and their correlation. Rheological properties of foods. Mathematical models and their application for non-Newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.
Practical: Determination of viscosity of liquid foods, guminess, chewiness, springiness and hardness of various fruits, vegetables and processed foods using texture profile analysis. Determination of force-distance relationship. Sensory evaluation/ subjective measurement and correlation between subjective and objective measurements of foods.

APFE 826 Food Production Technology   3(3-0-0)
Fundamentals of Operational Procedures in Food production, Management Procedures and Recordkeeping, Food Service Sanitation, Purchasing and Storage, Bakery Production and Management, Catering Management, Menu Planning and Cost Control, Nutrition, Food Service Management, Food Production and Management Technology.

APFE 827 Transport Phenomena in Food Processing   3(3-0-0)

Introduction to heat and mass transfer and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems. Applications in food processing including freezing and thawing of foods.
Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods. Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels.
Radiation heat transfer and its governing laws, its applications in food processing.
Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.
Practical: Solving problems on steady and unsteady state conduction with or without generation; numerical analysis; problems in natural and forced convection; radiation; design of heat exchangers; performing experiments on heat conduction, convection and radiation heat transfer.

APFE 828 Food Process Management and Control   3(3-0-0)

Present status of food industry in India; organisational structure of agro industry; major dimensions of agro based industries; risk management; unit operations of food industry; deteriorative factors and their control; laws and regulation related to food industry; quality management in food industry-quality standards and ISO: principles of food preservation and' processing; preservation through temperature reduction, water removal, radiation, heat processing, fermentation and use of preservatives, technology of extrusion, solvent extraction, refining and

hydrogenation; processing of dairy products; cereals milling; pulse milling; oil seeds crushing; processing of fruits and vegetable; confectionery; tea and coffee processing; food additive and toxicology; protection of food during storage, and transportation; packaging distribution of food products; case studies on project formulation-dairy products, oil industry, fruit and vegetables processing, milling-pulse, cereals etc.

Present status of fruit industry in India and emerging scenario; major fruit growing zones, management of fruit production technology for domestic and global market; post harvest handling technology harvesting, pre-cooling, grading, packing, storage and transportation for cooling, grading, packing, storage and transportation, pre and post harvest management for quality and shelf life; fruit processing industry; international trade in fruits problems and prospects and global marketing of fruits, and government policy, incentives *domestic and global trade.*

APFE 829   Simulation of Flow Patterns in Food Process Equipment   2(2-0-0)
Modeling: Classification of models; Models based on transport phenomena principles and applications; Population balance models and applications; Empirical models; Model parameters estimation.

Simulation: Sequential modular, simultaneous modular and equation oriented approaches; Partitioning and tearing; Simulation examples of fluid flow processes; Monte Carlo simulation. Conservation equations for mass, momentum and energy; Comparison of various numerical techniques for CFD; Review of finite difference and finite element methods; Solution to discretised algebric equation; Finite-volume method for diffusion problems; Finite-volume method for convection and diffusion problems – pressure velocity coupling; Construction of geometry and discreation using Gambit-Fluent's manuals; Commercial CFD solvers; Turbulance modeling;
Implementation of boundary conditions; Introduction to multiphase flow; Customizing commercial CFD solver; Unsteady state simulations.