# Department of Food Engineering

***M.Tech. Programme***

| Course No. | Course Title | Credit |
|---|---|---|
| | 1st Semester | |
| FE-501 | Food Processing Operations-I | 2+1 |
| FE-502 | Food Processing Operations-II | 3+0 |
| FE-503 | Transfer Process in Food Engineering | 3+0 |
| FE-504 | Food Chemistry and Microbiology | 2+1 |
| | 2nd Semester | |
| FE-551 | Food Plant and Equipment Design | 2+1 |
| FE-552 | Advance Dairy and Food Products Technology | 3+0 |
| FE-553 | Plant Utilities and Sanitation | 3+0 |
| FE-554 | Refrigeration System | 2+1 |
| FE-555 | Food Handling and Packaging | 3+0 |
| | 3rd Semester | |
| FE-649 | Seminar-I | 0+1 |
| | 4th Semester | |
| FE-699 | Seminar-II | 0+1 |
| FE-700 | Master's Research | 0+20 |

***Programme Details:***

**FE-501 Food Processing Operations-I 3(2+1)**

Overview of mechanical operations carried out in dairy and food processing, Particle size analysis, Pneumatic conveying of solid foods, Pressure drop and flow rate of air in fixed and fluid bed drying, Filtration of food, slurry filter medium and cake resistances, Filtration equipments, size separation through sieving, Particle movement in sedimentand centrifugal settling tank, solid bowl and disc bowl centrifuges, Operation of cyclone separator and self cleaning centrifuges, Agitation and mixing of liquid foods, powders and pastes, Drag and pressure flow mechanisms in screw press and extruder, Material handling system and device in food processing plants. Design of screw, bucket, belt, oscillatory vibratory conveyors, Refrigerated transport and transportation in insulated containers.

**Practical**

Flow properties of powders, Measurement of rupture angle and angle of intergranular friction of grains and powders, particle size analysis and energy requirement in communition, Measurement of cake resistance, filter medium resistance and compressibility factor for a constant pressure filtration process.

**FE-502 Food Processing Operations-II 4(3+1)**

Overview of thermal operations carried out in dairy and food processing, Role of water and water activity in foods, Control of water activity by addition of solutes and moisture removal. Different isotherms, their limitations and applicability. Irradiation and microwave processing of foods. Crystallization and freezing: Estimation of freezing time of foods, Equipments used for freezing water in food and for production of crystalline foods i.e. sucrose and lactose. Freeze concentration of liquid food, Concentration of liquid foods in batch and and continuous type evaporators, Energy saving by use of multiple effect evaporators with mechanical and thermal vapour compression. Mechanism of moisture removal in solid and liquid foods during drying: spray, freeze, roller and tray drying operations. Overview of contact equilibrium based separation techniques in dairy and food processing. Heat and mass transfer analogy, Estimation of mass transfer coefficients, balance in equilibrium stage operations. Distillation in aroma and solvent recovery in fruit concentration, alcoholic beverages and oil processing. Gas-liquid and liquid-liquid extraction principles and operations. Leaching and extraction for production of edible oil. Ultrafiltration and reverse osmosis in liquid food concentration. Osmotic drying of fruits.

**Practical**

Estimation of degree of sterilization of food during in-can sterilization, Moisture sorption isotherms from water activity measurement and its modelling, Determination of elevation of boiling point and depression of freezing point of some liquid foods (milk/fruit juices), Determination of flow pattern, porting arrangement and flow rate-pressure drop relationship in plate heat exchanger, Estimation and measurement of freezing time in a freezer. Concentration of liquid foods in evaporator.

**FE-503 Transfer Processes in Food Engineering 3(3+0)**

Momentum transfer- Equation of continuity, equation of motion, pipe flow, flow through porous media, Ergun's equation, fluidization of solids, principle of extrusion, Heat transfer- Fourier's law, conduction, convection and radiation heat transfer. Steady state and transient heat transfer, heat transfer in Cartesian and cylindrical coordinates, Analytical and numerical solutions to transient state heat transfer. Heat exchangers without and with heat loss, effectiveness and transfer units. Mass transfer- Molecular diffusion, Fick's law, diffusion in solids, liquids and gases, heat and mass transfer analogy.

**FE-504 Food Chemistry and Microbiology 3(2+1)**

Chemical composition of food, structure, properties, chemical and biochemical functions of food constituents: water, proteins, fats, carbohydrates, vitamins, enzymes and minerals, pigments, colour and flavours. Food additives and contaminants, Chemical changes during processing, chemical spoilage of food. Introduction to food microorganisms, morphology and characteristics of bacteria, yeasts and molds. Factors affecting microbial growth and decay, microbial growth and death kinetics. Food poisoning, intoxicating and infective organisms, microbial spoilage of foods.

**Practical**

Analysis of food for proximate composition-water, protein, fat, carbohydrate, minerals, vitamins and fibers. Determination of acidity and pH, sugars, enzyme activity, free fatty acids, iodine value, peroxidise value, determination of adulterants and toxins in foods, Isolation and identification of microorganisms, Microbial examination of water and some selected foods.

**FE-551 Food Plant and Equipment Design 3(2+1)**

Physical properties of food materials and energy balance calculations for preliminary estimation of plant capacity and equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant. Materials of construction: welding a machining of stainless steel, design of storage vessels for liquid food and grains. Design of vessels for drum drying. Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps. Design of fluid conveyance systems, pipe, sanitary pipe fittings and valves. Performance characteristics and selection of centrifugal positive displacement sanitary pumps. Design of CIP system. Design of heat exchange equipments: plate, scraped surface and extended surface for heating and cooling of gas and liquids. Design of evaporator calandria, vapour separator and condenser. Design considerations, location of food plant, Equipment lay out and ventilation in food processing plants.

**Practical**

Design, planning and flow diagrams including materials, service requirements, economic analysis, short projects on design of systems and plants for food processing.

**FE-552 Advanced Dairy and Food Products Technology 3(3+0)**

Basic principles and methods of food processing and preservation, Emerging technologies in food processing, Food additives and preservatives, Food laws and standards. Effect of processing on acceptability and nutritive value of food, process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, infant and baby food, ice-cream, cheese, butter, fermented milk and indigeneous dairy products, cereals, vegetables, fruits, meats, poultry and egg products, alcoholic and non-alcoholic beverages, Tea, coffee and cocoa.

**FE-553 Plant Utilities and Sanitation 3(3+0)**

Steam generation, Boiler design considerations, forced and induced draft, Flue gas analysis and performance analysis. Water treatment for prevention against boil corrosion

and scale formation on heat exchange equipment. Water treatment against microbial contamination, Process plant sanitation- chemistry and CIP cleaning systems. Detergent properties and corrosion inhibition. Waste water treatment- BOD and its reduction, design of batch and continuous type effluent treatment system. Principles of biochemical reaction engineering, Process plant automation- analogue, digital, PI and PID control, temperature and pressure measurements, advanced instrumentation.

**FE-554 Refrigeration Systems 3(3+0)**

Analysis of refrigeration cycle, principles of psychrometry properties and processes, Air washer, cooling towers, dehumidifiers, wet bulb and dew point temperature, multistage cycle, cascade cycle and their optimization. Properties of refrigerants, air refrigeration cycle, dry ice manufacture, vapour absorption cycle and its components, Refrigeration evaporator, compressor, condenser and flow control; design, lubrication, charging and testing of refrigeration plants, defrosting, capacity control, system component balancing. Design and construction details of unitary refrigeration equipment.

**FE-555 Food Handling and Packaging 3(3+0)**

Overview of material handling system and devices in food processing plants, design of screw, bucket, belt, oscillating and vibratory conveyors. Refrigerated transport and transportation of insulated containers. Packaging materials, their characteristics and properties, manufacture of plastic films, foils, laminates, retortable pouches, rigid plastic container, paper and corrugated fiber board, design of shipping carton and containers, rigid packaging tin plate and aluminium. Design of aerosol container, metal tubes, glass containers and closures. Labels and printing in packaging, Packaging requirements for different processed and unprocessed foods (i.e. fruits, vegetables, grains, baked foods, dairy products etc.). Principle of working of various types fillers, form-fill seal machine, gas packaging, controlled and modified packaging, Shelf life prediction of foods in packages. Quality control in food packaging, Product safety and packaging regulations.