# DETAILED PG SYLLABUS

### A. PRE-REQUISITE COURSES

### STW - Scientific & Technical writing

As approved for other P.G. Programmes.

### FPT - 711 Material Handling

Principal material handling equipment, characteristics, economic selection and application of equipment, typical problem analysis methods using available data, basic study of plant layout, principles and techniques in food processing plants.

### Practicals:

Study of various types of material handling equipments. Functions and principles of operation of various material handling equipments. Selection of conveying system. Maintenance & management requirements of various types of material handling equipments.

### FPT -712 Engineering Materials & Maintenance of Equipments.3(2+1)

Properties, selection and application of ferrous metals, iron and steel, cast irons, plain carbon steels, stainless steels, alloy steels, tool steels, nonferrous metals, copper and copper alloys, bearing metals, aluminium and its alloys, carbides, ceramics, rubber and plastics, refractories and their applications, lime and cement, protective coatings, paints, varnishes, lacquers, resins, lubricating oils and fuels. Thermo-physical and mechanical properties, corrosion & its effect on properties. Maintenance, break down and preventive, maintenance records, planning, needs of a maintenance shop.

### Practicals:

Steel making process introduction to non-ferrous metals and alloys. Principal methods of hot working of metals. General characteristics of metals and non metals for food industry application. Characteristics of protective coatings.

### FPT – 713 Mechanical Measurements & Instrumentation2(1+1)

Introduction to generalized instrumentation system; Performance characteristics of instruments; Absolute and secondary measurements; Calibration of instruments; Sensors and transducers; Measurement of humidity, temperature, moisture contents, fluid flow, pressure, force, strain, torque, sound, vibration, calorific values, radiation, etc; Data acquisition, storage & retrieval systems; Process control & devices.

### Practicals:

## 3(2+1)

Measuring and testing equipments. Strain gauge transducer mounting & wiring. Capacitive rotational displacement transducer. Thermocouple uses and calibration. Experiments on RTD, thermistors, expansion gauges etc. Using PH meter, discharge meter, anemometer and moisture meter. PLC's, Dataloggers and dataprocessors.

### FPT -714 Refrigeration & Air Conditioning

Brief review of vapour compression, absorption and ejector cycle; Refrigeration system balance and multiple evaporation systems; Design data of condensors, evaporators and cooling towers; Refrigeration piping and plant controls; Application of psychrometry in cold storages and ice-bank system design, cryogenics; Use of solar energy in refrigeration; Thermal insulation, water vapour barriers, methods of dust and odour control, bacterial contamination; Maintenance of refrigeration and airconditioning machinery and equipment; Design of cold storages and humidifiers.

### Practicals:

Various types of refrigeration systems used in food plants. Cooling load calculation. Design of cold store. Design & selection of refrigerating equipments for specific food processing applications. Design of solar energy assisted cold storage units.

### FPT – 715 Process Equipment Design

# Codes and regulations. Materials of construction. Design pressure and temperature loadings, allowable stresses, deterioration. Design for external and internal pressures. Cylindrical and spherical shells, formed heads, reinforced openings. Fabrication requirements, non-destructive examination, pressure tests of completed vessels, stress evaluation. Piping materials and testing. Overall economic and safety consideration. Heat transfer equipments, construction codes, general design considerations, tube headers, rolled and welded tube joints, baffles and tube bundles, construction. Corrosion in heat exchangers, heat exchanger costs, heat transfer coefficients. Maintenance of process equipment. BIS standards for different equipments. **Practicals:**

### Practicals:

Design of pressure vessels & pipe line, storage tanks, sterilizers, process vats, plate/ shell & tube heat exchanger, tube type / finned type heat exchangers. Design of cabinet,/ tray, fluidized bed and pneumatic dryer. Design of pulper & crushers. Design of mixing & blending equipments. Design of cold storage for a given capacity.

### FPT – 716 Heat & Mass Transfer in Food Processing

Heat transfer involving conduction, convection and radiation. Different approaches to problem solution including finite difference and finite element techniques. Molecular transport in gases, solids and liquids, Multi-component diffusion, molecular diffusion coefficients, unsteady diffusion, turbulent transport, interphase mass transfer, diffusion in porous solids, diffusion in biological solutions.

1

### 4(2+2)

### 4(2+2)

### 3(3+0)

### FPT –721 Crop Science & Food Resources

Classification of crops, Scope of horticulture and vegetable crops. Soil and climatic requirement for crops. Modern methods of cultivation. Garden tools. Management of seeds. Importance of livestock. Basics of anatomy and physiology of ruminant and non-ruminant domestic animals, poultry and fish. Recent trends in livestock husbandry, poultry and fish production.

### Practicals:

Method of cultivation for various horticultural crops, cereals, pulses & oilseed crops. Study of climatic & soil requirements for different crops. Modern techniques of livestock, animal husbandry, poultry & fish production. Food resource availability & management. Biochemical changes during ripening. Identification of different varieties of cereals, oilseeds, fruits, vegetables & spices.

### **B. MAJOR COURSES**

### B.1 CORE COURSES

### FPT - 912 Engineering Properties of Biological Materials3(2+1)

Biological materials; uniqueness in relation to other materials; Physical characteristics: shape, size, volume, density, surface area; Mechanical properties: strengths, stresses, strains, time effects, rheological models and equations; Aerodynamic characteristics and frictional properties; Optical properties; Electrical & electro-magnetic properties; Application of engineering properties in designing, handling & processing machines and systems.

### **Practicals:**

Study of various equipments & systems for different engineering properties. Measurement and analysis of various physical properties of food materials at different moisture content. Measurement of gravimetric properties of food materials. Measurement of moisture content of food materials. Determination of rheological properties for selected materials. Determination of optical properties for selected materials.

### FPT – 925 Biotechnology in Food Processing

# Introduction, general characteristics of enzymes. The nature of enzyme catalyzed reactions. Enzyme inhibition and activation. Natural enzymes of food, their role and significance in food products. Purification of enzymes from various sources and their modification. Immobilization by physical and chemical methods. Application of soluble and immobilized enzymes in food processing. Immobilized enzyme reactors. Legal aspects of use of enzymes in food industry. Bioengineering of enzymes. Production, purification and characterization of carbodyrases /

hydrases, proteolytic enzymes, lipases, esterases and oxidoreductases. Applications of these enzymes in food preservation & processing.

### Practicals:

Study of different type of enzymes & their characteristics. Isolation of soluble proteins & their characterization. Isolation & purification of enzymes from various sources. Determination of specific activities of an enzyme.

### FPT – 931 Unit Operations of Food Processing

3(2+1)

Cleaning of raw materials and related equipment, sorting and grading methods and equipment, size reduction and screening of solid food materials, mixing and emulsification, filtration and separation, centrifugation, extraction and leaching, heat processing, evaporation and freezing methods and equipment, drying and storage.

### Practicals:

Measurement of contaminants in raw food material. Studies on the performance of selected sorting and grading equipment. Studies on the determination of fineness modulus and energy requirements in size reduction of solid foods. Measurement of mixing index in solid – solid mixing. Measurement of separation efficiency of centrifugal separator. Measurement of regeneration rate and thermal efficiency in an HTST pasteurization system. Study of various types of evaporators. Visit to agricultural processing industries.

### FPT – 937 Energy Conservation in Food Processing Plants3(2+1)

Conservation principles, prevention of losses, improving efficiencies, analysis of different conservation systems and comparison, co-generation, use of solar energy and heat pump, reduction and quantification of waste, factors effecting energy needs such as size, site selection, location, schedule, environmental conditions, process parameters, and plant design, design considerations for organized and unorganized sectors, recent trends.

### Practicals:

Understanding of various energy utilizing operations in food processing industries. Identification of processes needing energy auditing. Calculations for energy auditing for selected processes. Studies on certain energy conservation devices & systems. Visit of food processing industry having co-generation or energy conservation systems.

### FPT – 939 Advanced Food Engineering

Momentum transfer: Compressible flow, nozzle flow, porous media flow, fluidized bed flow; Non-Newtonian liquid flow in pipes and slits, apparent viscosity, generalized coefficient of viscosity, generalized Reynold's number.

Heat Transfer: Conduction in composite systems; Heat exchangers – effectiveness/NTU relationships; Conduction/convection systems – fins; Unsteady state heat conduction – analytical and graphical solutions for plates, cylinders and spheres;

Mass Transfer: Molecular diffusion and Fick's Law – steady state and equimolar counter diffusion, diffusion through varying cross sectional area; Mass transfer coefficients – their interdependence; Analogy between momentum, heat and mass transfer.

Principles of Food Preservation: Mass and energy balance; Water activity, sorption and desorption isotherms.

Freezing: Freezing point depression, freezing devices. Size Reduction: Mechanics and energy consumption, equipment. Size Separation: Screening and screen effectiveness; Filtration, clarification and thickening; Cyclones. Application of RO & UF in Food Processing.

### **Practicals:**

Measurement of heat transfer through composite slab under steady state conditions. Measurement of thermal conductivity & thermal diffusivity of selected food materials. Study of various types of heat exchangers. Measurement of moisture diffusion of solids of biological origin. Study of different RO & UF equipments used in food industry.

### FPT – 955 Advanced Food Process Technology3(2+1)

Present status of food processing industry in India and abroad. Application of recent technologies for food processing. Advanced process control, instrumentation and automation in food processing industries.

### **Practicals:**

Market survey of instant / Ready-to-serve and convenience food mixtures. Extraction of spice oils & development of flavour enhanced foods. Visit to related food industries.

### FPT – 962 Food Plant Management & Resource Planning

Analysis of comprehensive process engineering, problems in production planning, material handling in procurement, production and marketing, time study, industrial organization and plant layout, general discussion strategies, discussion under risk and uncertainty, inventory and control, purchase and sale management, marketing and research, data processing.

2(2+0)

4

### FPT – 996 Research Methodology

Basic concepts of research, Planning and organization of experiments for data acquisition and analysis. Type of research methods, experimental designs, equipment and principles underlying their uses. Scientific periodicals and literature related to the subject. Form and style of writing research papers, review articles, research reports and thesis. Selection of research problem and preparation and submission of research projects. Interpretation and evaluation of research data, considerations and requirements for setting up a research laboratory.

### FPT – 997 In – Plant Training

Eight weeks in-plant training at relevant food processing industry, machinery manufacturer, marketing or other agency.

### FPT – 998 Special

Investigation of selected problems of special interests in Food Processing Technology to individual student. The work includes library work, field or laboratory research, recording data, analyzing data and writing of research paper etc.

### FPT – 999 Seminar

Preparation, presentation and discussion by students on current topics / interests in Food Processing technology.

### **B.2 OPTIONAL COURSES**

### FPT – 911 Post Harvest Technology of Agro-produce3(2+1)General

post production operations; PH handling chain for major crops; primary, secondary and tertiary processing systems for all crops; Engineering technologies and plant system; Major post harvest equipment & machinery; Management concepts and their application to management of post harvest systems; packaging and distribution; network analysis in post production system.

### **Practicals:**

Study of major post harvest operations such as cleaning, grading, storage, size reduction and packaging. Study of various modern post harvest equipments & machinery.

### FPT – 924 Food Additives & Preservatives

### 2(2+0)

# 2(0+2)

### 1(1+0)

2(0+2)

### 2(2+0)

Food additives: role of various types of food additives in foods, food dispersions; food sols, food gels, food emulsion and foams. Food preservatives: mechanism of their use, doses, legal aspects etc.

### FPT – 926 Food Standards & Quality Assurance

Study of ISO, HACCP, PFA, FPO, AGMARK, BIS quality management system. General principles of quality control, quality attributes of food products and its evaluation. Food standards, laws and regulations for maintaining quality. Laboratory requirements, Statutory and optional food standards, food plant sanitation, Sampling and estimation for quality evaluation, Statistical quality control, Testing hypothesis.

### Practicals:

Study of general quality requirements for various food products. Collection & familiarization of national & international standards such as ISO, HACCP, FPO, PFA, AGMARK etc. Detailed study of quality control equipments & methodology. Estimation of various quality parameters of different raw materials & finished products. Testing of selected foods by sensory evaluation. Visit to Quality Control laboratories & industry.

### FPT – 927 Effluent Treatment & Management

Unit operations in disposal and treatment of food processing industries' waste, physical, chemical and biological processes for treatment and disposal, comparison of food processing industries' waste disposal methods, design and layout of food processing industries' waste disposal systems, environmental considerations. Legal and pollution control aspects. **Practicals:** 

Study of effluent generation processes of the food processing industry. Study of various treatment processes for food processing effluents. Characterization of selected effluents. Design calculations for specific effluent treatment systems. Visit to effluent treatment plants in food processing industry.

### FPT – 932 Thermal Processing of Foods

Overview of thermal operations carried out in food processing. Pasteurization and Sterilization: microbial destruction, kinetics of loss of nutrients; UHT processing; action of chemicals on death kinetics of microbes; aseptic packaging; irradiation and microwave processing of foods; Crystallization and Freezing: Plank's law and estimation of freezing time of foods; equipment used for freezing; freeze concentration of liquid food.

6

### 3(2+1)

# 3(2+1)

Concentration and Evaporation: Concentration of liquid foods; heat and energy balance in multiple effect evaporators; design of calendria in the evaporators, falling and rising film evaporators; mechanical and thermal vapour recompression systems.

### **Practicals:**

Study of different thermal processing equipments for their construction & operation. Determination of quality of selected thermally processed foods. Thermal processing of selected food products. Detailed study of different crystallization & freezing equipments. Study of freezing characteristics of selected foods. Design calculation for different equipment for thermal processing.

### FPT – 933 Drying & Dehydration

### 3(2+1)

Mechanisms of moisture removal, drying theories and drying parameters, drying of low, medium and high moisture foods and as also liquid foods, mathematical modeling and simulation of drying processes such as single kernel drying and deep bed drying, drying of liquid foods, application of mathematical models to drying of foods, various types of dryers and their applications, selection criteria and selection of dryers, heat requirement and thermal efficiency of drying system, design of drying equipment and systems, effect of drying and dehydration of food quality.

### **Practicals:**

Drying characteristics of granular food materials in thin beds. Drying characteristics of granular food materials in deep beds. Simulation and modeling of deep bed drying systems. Drying behaviour of selected food materials in fluidized bed. Tray drying characteristics of a high moisture food. Spray drying behaviour of liquid foods. Study of various types of drying systems. Design exercises on various types of drying systems. Field visit to drying installations.

### FPT – 934 Bio-Process Engineering

Introduction of bio-processing of foods, industrial fermentations in food processing: basic principles and operations, fermentation systems; design analysis of bioreactors of various types; product recovery operations, equipment and systems; on line and off line bio-process instrumentation and sensors, modeling, simulation and scale-up bio processes, equipment and system; control of bio-processes and, process economics.

### Practicals:

Preparation and inoculation of PDA medium and harvesting. Preparation and inoculation of YPSS medium and harvesting. Preparation and inoculation of wheat bran medium. Harvesting, recovery and purification of enzymes. Characterization and measurement of enzyme activity. Enzyme treatment of oilseeds and its effect on oil yield. Studies on the performance of batch and microprocessor controlled fermenters.

7

### FPT – 935 Process Control in Food Industry

Introduction to control system- feedback and feed forward control strategies, block diagram, Laplace and inverse Laplace transforms mathematical models of physical systems, transfer functions steady state analysis. Dynamics of first and second order systems. Mode of control and generation of control action: PPI and PID controllers; Final control elements and valve positioners; Frequency response and root locus analysis, stability and Quality of overall control systems, digital control. Electronic, pneumatic and hydraulic control systems and their application in food processing industry.

### **Practicals:**

Identification of various types of process control systems. Constructional & operational details of different process control instruments & equipments. Design of control systems for selected processes / products.

### FPT – 936 Design & Layout of Food Processing Plants

Application of design Engineering for Processing equipment; Design parameters, Codes and materials selection; Design of handling and milling equipments, dryers, heat exchangers, pressure vessels; Optimization of design with respect to process efficiency, energy and cost; application of computer techniques in design optimization.

Salient features of processing plants for cereals, horticultural crops, poultry and meat products, selection of process controls and handling equipments, plant layout, plant elevation, location of plants, sanitation, plant installation, power and power transmission, project design, flow diagrams, cost analysis.

### Practicals:

Preparation of designs & layouts of various food processing plants. Design of various ancillary plants & other factory facilities. Design & layout of effluent treatment and handling plant.

### FPT – 938 Plant Utilities & Sanitation

Steam generation, boiler design considerations, forced and induced draught flue gas analysis and performance analysis. Water treatment for prevention against boiler 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.

### Practicals:

Study of various types of boilers and their constructional & operational details. Boiler design & performance analysis. Study of different designs & layouts of ducting / piping. Testing of water

2(1+1)

### 3(2+1)

quality & standards. Details of water treatment equipments & structures. Types of detergents & their properties. Study of air supply equipments & their operation. Study of waste water flow in food industry.

### FPT – 941 Technology of Cereals & Pulses Processing 4(3+1)

Introduction to post harvest operation to process cereals, pulses, moisture content, cleaning and separation. Principal methods of parboiling, physical - chemical changes during parboiling. Nutritional and cooking qualities. Grain milling operations. Rice milling, milling of wheat, corn, pulses. Handling equipment for a grain market. Utilization of by products of cereals, pulses, oil seeds and spices. Packaging of cereals, pulses and their products.

### **Practicals:**

Determination of different physical & chemical constituents of various cereals & pulses being processed. Constructional & operational details of different machines & equipments used in grain / pulse mills. Determining milling characteristics of selected cereals & pulses as influenced by machine & grain parameters. Determining quality of selected milled products. Visit to various rice mills, dal mills, flour mills etc.

### FPT – 942 Technology of Oilseeds & Oil Processing3(2+1)

Sources of fats and oils, cleaning and storage of oilseed, methods and equipments for extraction, refining and hydrogenation of oils, storage stability, use in food and other industries, manufacture of margarines shortenings, salad oils and dressing etc., quality control of products.

### Practicals:

Determination of physical & chemical constituents of selected oilseeds. Study of different equipments / systems for oil extraction, refining, packaging etc. Determination of quality of different oils & oil products. Estimation of various biochemical changes during storage of oil & oil products.

### FPT – 943 Technology of Milk & Milk Products

Market Milk: composition, factors affecting composition of milk, physico-chemical properties of milk, collection, judging and grading of milk, flavor defects in milk, their causes and prevention, platform test and quality.

Special Milk: sterilized milk, homogenized milk, flavored milks, standardized milk, recombined milk, toned and double toned milk.

Butter, ice-cream, cheese, dried milks and quality control of milk processing. Indigenous dairy products like Khoa, Shrikhand, Ghee etc.

### Practicals:

Conducting platform tests on reception of milk. Sampling, judging & grading of milk. Estimation of

### 4(3+1)

fat percentage in milk. Production of flavoured milk. Cream separation. Production of butter, paneer and yoghurt. Manufacturing of ice cream, khoa, shrikhand, ghee etc. Quality control of milk processing.

### FPT – 944 Technology of Horticultural Crops Processing4(3+1)

Principles of drying mechanism of drying of solids, drying rate curves etc. Engineering technology in food processing for rejected foods of commercial importance for plant origin. Properties of fruits and vegetables, process parameters and equipment for sorting, washing, handling, peeling, slicing, blanching, mixing and handling, chilling: packages: transportation storage and preservation technology.

### Practicals:

Determination of mechanical damage during handling and transport of fresh fruits and vegetables. Effect of blanching on enzyme inactivation in vegetables. Canning studies on fruits and vegetables. heat penetration characteristics of fruits and vegetables and determination of lethality of the process. Identification and establishment of critical control points in the processing of fruits and vegetables. Production of various fruit products on laboratory scale. Design and layout of a fruit and vegetable processing plant. Visits to commercial fruit and vegetable processing plants.

### FPT –945 Technology of Spices & Plantation Crops Processing3(2+1)

Spices, their physical and biochemical characteristics, drying and processing of different spices, familiarization with handling, processing, packaging and storage equipment, their constructional features, operations and maintenance, processing and utilization of spices by-products, economics of processing.

### Practicals:

Determination of drying characteristics of spices in thin layer dryer, cross flow dryer, bin dryer and rotary dryer. Study of turmeric boiler & polisher. Study of different products prepared from plantation crops like coconut, oil palm, cashew nut, rubber arecanut etc. processing of tea & coffee.

### FPT – 946 Technology of Fish, Meat & Poultry Products

Processing and preservation of fish, meat and poultry products. Structure, composition, quality characteristics of products. Heat processing, curing, freezing, drying and packaging of products; Hygiene, sanitation and quality control during processing of fish, meat and poultry products. **Practicals:** 

Identification of structure & composition of fish. Identification of structure & composition of meat. Identification of structure & composition of poultry produce. Dehydration characteristics of fish. Canning of fish. Freezing of fish. Packaging of fish & its products. Visit to fish processing & packaging unit. Measurement of meat tenderness. Preparation of different products from meat. Visit to slaughter houses. Preparation of various products from eggs.

### FPT – 947 Technology for RTE/RTC Food Products 3(2+1)

Various types of RTE/RTC products, Source of raw materials for RTE/RTC food products. Technology of production. Machinery, equipments and engineering, Market study and requirement of consumers, Packaging, Quality control.

### **Practicals:**

Recipes for different RTE / RTC products. Preparation of important RTE / RTC products. Packaging & storage studies of different RTE / RTC products. Determination of nutritional quality of different RTE / RTC products.

### FPT – 948 Technology of Bakery & Confectionary Products3(2+1)

Ingredients, leavener and yeast foods, shortening, emulsifiers and antioxidants, sweeteners and malt syrup, Ingredients from milk and eggs, fruits, vegetables and nuts, spices, flavors and colors. Recipes formulation and process for different bakery and confectionary products. Equipment requirement and engineering, Quality assurance, preservation of bakery and confectionary products, Sanitation and safety of plant.

### Practicals:

Preparation of fermented as well as cake & confectionary products. Effect of various ingredients on quality of bakery products. Preservation techniques of bakery products. Qualitative analysis of raw ingredients and finished products.

### FPT – 949 Technology of Sugar & Jaggery Processing

Physical and chemical properties of sucrose and reducing sugars. Composition of raw materials. Can cleaning, milling and extraction of juice, Purification of juice, Sugar Manufacturing technology and engineering, handling techniques of sugar, molasses. Manufacturing of sugar from sugar beet, Sugar refining, Quality standards. Jaggery manufacturing processes & plants, jaggery products and their quality control.

3(2+1)

### Practicals:

Constructional & operational details of sugarcane crushers and allied equipments. Constructional & operational details of juice purification equipments. Constructional & operational details of juice

concentration equipments. Constructional & operational details of jaggery making equipments. Determination of qualitative parameters of market sugar & jaggery.

### FPT – 951 Fermented Food Products Technology

Microbiology in fermentation, the range of fermentation processes, Design of a fermentor, Types of fermentors, Instrumentation and control, Recovery and purification of fermentation products, Fermentation process and economics.

### Practicals:

Constructional & operational details of different fermentors. Identification & handling various microbes and enzymes used for food fermentation. Preparation of media for different kinds of fermentation. Preparation of different fermented food products. Assessment of different quality parameters for various fermented foods. Visit to fermented food industry.

### FPT – 952 Food Irradiation Technology

Irradiation, principles and techniques of irradiation. Application of irradiation to food products. Equipments and instruments for using irradiation technology. Advantages, disadvantages & limitations of irradiation technology.

### Practicals:

Constructional & operational details of different equipments for irradiation of food. Calculations & exercises for determination of doses of irradiation for different kinds of food items.

### FPT – 953 Packaging Technology & Equipments

Function of Packaging, Packaging materials, their structural qualities, Effect of these materials on packed commodities, Methods of package testing and their performance evaluation, scope of locally available packing materials in industry. Types of machinery and equipments for packaging. Economics of packaging, indigenous methods of packaging food products, their merits and demerits, scope for improvements, rent developments in packaging systems and equipment.

### Practicals:

Identification of various packaging materials suitable for food items. Studying constructional & operational details of different equipments used for food packaging. Determination of packaging material quality. Visit to packaging material manufacturing factories. Visit to food industry showing packaging of different products.

12

### 2(1+1)

### 3(2+1)

### FPT – 954 Management of Byproducts & Wastes of Food Industries 3(2+1)

Engineering and bio-chemical properties of byproducts & wastes, present waste utilization in various industries, formation of byproducts and waste, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of briquetted charcoal, generation of electricity using surplus biomass, producer gas generation and utilization, waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants. **Practicals:** Measurement of combustion characteristics and calorific value of various agricultural wastes and rice husk. Performance evaluation of various types of furnaces on agricultural wastes. Performance evaluation of gasifier on agricultural wastes. Ammonification of wheat and paddy straw for feed value addition. Pyrolysis of rice husk and measurement of resultant products. Briquetting characteristics of agricultural wastes. Alcohol production from agricultural wastes.

### FPT- 956 Advanced Protein Technology

Survey of protein availability and world's protein need; isolation techniques from conventional and non-conventional sources including single cell protein, leaf protein, seed protein and proteinoids; Legumes-Proximate composition, amino acid composition of proteins, trypsin inhibitors, processing methods, methods of cooking, etc.; newer techniques in protein processing including texturization, tenderization; protein-rich formulation, simulated protein foods. Recent advances in the physical, chemical and microbiological aspects of separation, processing, characterisation and utilization of milk proteins.

### FPT- 957 Advanced Lipid Technology

Recent developments in fat technology including encapsulation, fractionation, hydrogenation and alterations in physical and antioxygenic properties; analytical techniques including rheological measurements and flavour evaluations; newer findings on the nutritional role of fat. Newer concepts in the processing, manufacture, storage, packaging, utilization and economy of fat - rich milk products.

### FPT- 958 Enzymology

Enzyme nomenclature and classification, assay, isolation, purification and characterization; structure conformation, specificity, mechanism of action, transient and steady state kinetics, active site mapping, regulation of enzyme activity, multi enzyme complexes, immobilized enzymes, application of enzyme in chemical and food industry, clinical applications of enzymes. **Practicals:** 

3(3+0)

### 3(2+1)

### 3(3+0)

Isolation of soluble proteins and their characterization. Isolation and purification of enzymes. Determination of activity and specific activity of an enzyme. Determination of Km and V max. enzyme kinetics; enzyme inhibitors.

### FPT- 959 Functional Foods & Neutraceuticals

### 3(2+1)

2(2+0)

Concept of probiotics, prebiotics and symbiotic, characteristics of functional foods and Neutraceuticals, raw materials used and additives used functional foods, different types of functional foods – liquid, semi-solid and dried. Technology for manufacture of functional foods, viability of probiotic organisms and shelf-stability of foods, composition and nutritional value, health and clinical benefits of consuming functional foods, quality assurance, labelling, marketing aspects of functional foods. **Practicals:** 

Study various probiotic organisms and their characteristics. Method of their propagation and maintenance. Preparation of liquid, semi-solid and dried functional foods in laboratory. Compositional, microbiological, nutritional analysis of functional foods. Study of viability of probiotic organisms in functional foods. Testing nuetraceutical for some of the clinical benefits. Visit of neutraceutical producing industry.

### FPT – 961 Project Engineering & Management

Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure. Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting. Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT. Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management

C. MINOR COURSES

### C.1 BIO – ENERGY

### BE – 911 Non- conventional Sources of Energy

3(2+1)

General introduction to renewable energy sources and technologies, their importance for sustainable development and environmental protection, Production and potential. Solar Radiation, Solar Thermal, Solar PV cells, Biomass, Biogas, Wind energy, Other renewable energy: Introduction and principles of Geo- thermal, Tidal, wave, OTEC and mini and Micro Hydro Energy Systems.

### Practicals:

### 14

Study of solar thermal, solar photo-voltaic and solar refrigeration systems. Study of various biogas plants and their designs. Study of biomass gasifiers. Study of different wind energy devices used for water pumping, electricity generation etc. Study of other renewable energy devices.

### BE – 912 Solar Energy Systems & Management

Importance of solar energy and its application in crops drying, air and water heating, cooking, lighting, seed treatment and preservation. Principles and design criteria of solar water heaters, solar crop dryers, solar cookers and solar absorption refrigeration systems, storage of energy by rock, water and phase exchange medium. Measurement of solar radiation, reflectivity, absorptivity, transmissivity and thermal conductivity. Design of photovolatic cells. Economics of various solar energy systems. Operation and maintenance of solar operated appliances systems and equipments.

### **Practicals:**

Design of solar crop dryer, solar air heater and water heater. Design of solar cooker (concentrating and box type). Design of solar refrigeration system. Measurement of solar radiation using various types of pyranometers. Operation & maintenance of solar operated appliances.

### **BE – 913 Wind Energy Systems & Management**

Concept of wind power and its use in water lifting and power generation. Principles and design criteria of different types of mill, operation and maintenance of wind mills, Economics of operation of wind mills. Recent advances in wind mill engineering at national and international levels. Management of project running on wind mill energy. Management of power generated by wind mill for lighting, water pumping industries and various operations in Agriculture.

### **Practicals:**

Study of various types of blades used in windmills. Design of different types of windmill devices. Calculation of economics of operation of wind mill. Management systems for power generated by wind mills for lighting, water pumping and other operations. Visit to various wind energy farms.

### BE – 914 Biomass Energy Systems & Management

Identification of various forms of biomass. Importance of biomass and its use in gasifiers, briquetting, water pumping, power generation, cooking and furnaces. Plantation for renewable energy i.e. wood as a fuel charcoal, producer gas. Different types of species for energy plantation. Design of different gasifiers, furnaces, stoves, and briquetting plants. Economics of

### 4(3+1)

### 4(3+1)

### 4(3+1)

various systems of biomass run plants, equipments, operation and maintenance. Design of rural base industries run on biomass. Concept of biogas, different types of biogas plants. Bio-chemical reactions in biogas from municipal and industrial wastes. Operation and maintenance of biogas plants. Economics of biogas plants.

### Practicals:

Identification of different forms of biomass for use in biogas plants, gasifiers, briquetting, furnaces etc. Estimation of calorific value by various gases. Design and cost analysis of biogas plants of various sizes and types. Operation and maintenance of biogas plants. Design of different gasifiers, stoves, furnaces etc. Design and economics of rural based industries run on biomass. Visit to various industries using biomass energy systems.

### BE – 921 Bio - environmental Engineering

Biosphere concept; major ecosystem and sub-systems; biodiversity, conservation of natural resources and techniques of maintaining the balance; environmental modification and its priority; environmental stress and pollution: types and sources; Environmental quality; standards, measurement and monitoring; agricultural pollution and its control.; BOD and COD.

Food behavior and spoilage in storage. Economical aspects of fruit and vegetable storage, modified atmospheric storage and control of its environment, storage sanitation. Storage of grains: Destructive agents, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through natural ventilation, mechanical ventilation, artificial drying, grain storage structures such as Bukhari, Morai, Kothar, silo design, control of environment inside silo. Introduction to green house and its application in agriculture.

### Practicals:

Study of ecosystems and natural resource management for maintaining ecological balance. Types and sources of environmental stress and pollution. Estimation of P<sup>H</sup>, EC, hardness and other quality aspects of waste water. Estimation of BOD and COD. Study of various effluent treatment methods. Visit to food industry and study of pollution control measures. Types of storage systems for fruits & vegetables and control of its environment for extending shelf life. Effect of various measures such as MAP, CAS, ventilation etc. on changes in food products. Study of various types of greenhouses and environmental control for enhancing crop production.

### BE – 999 Seminar

### **C.2 DAIRY TECHNOLOGY**

### 3(2+1)

1(1+0)

### 3(3+0) DT-721 Advances in Concentrated & Dry Milk Technology

Newer concepts in milk quality in relation to processing and manufacture of concentrated and dry milks. Effect of industrial evaporation/condensing on the characteristics of resulting products, principles of manipulation of time-temperature factors for obtaining different desired endproducts, importance of preheating in relation to heat stability and gelation.

Advances made in the processing, manufacture, packaging and storage of concentrated and dried milks. Recent developments in drying techniques. Recent advances in the formulation and processing of new dairy foods based on concentrated and dried milks.

Critical evaluation of infant milk foods, need for modifications, newer technologies and formulations.

### **DT-722 Milk By-products Technology**

Need for by-products utilization in the dairy industry. Composition and nutritive value of important dairy by-products. Recent advances in processing and utilization of dairy by-products, application of newer techniques in concentration and dehydration of different whey systems. Developments of new processing and products for economic use of by-products. Principles of industrial preparations of lactose. Manufacture of edible casein, fortification of edible casein in some foods.

### **DT-724 Technology of Indigenous Milk Products**

Significance and role of indigeneous milk products in Indian dairy industry and economy; Characteristics, composition and legal aspects of various indigenous products. Quality of milk in relation to their manufacture, traditional and improved/standardized methods of production, basic principles involved; physico-chemical changes occuring during manufacturing and subsequent storage, quality attributes, judging and grading, packaging, shelf life and preservation at ambient and low temperature.

Scope and need for improving the existing techniques of manufacture, storage and packaging, latest innovations and their impact on quality, shelf life and economy of production.

### **DT-725 Advances in Cheese Technology**

### 3(3+0)

Milk in relation to modern cheese making process. Treatments such as chilling and low

### 3(3+0)

### 3(3+0)

temperature storage, heating, clarification, bactofugation, homogenizatiion, hydrogen peroxidase-Catalase treatment, preconcentration, etc. of milk in relation to cheese making. Advances in renneting of milk - rennet and its substitutes, chemistry of rennin action, effects of rennet substitutes on cheese quality. Cheese starter and new innovations therein. Mechanization of cheese making processes and problems connected there to. Cheese ripening and newer concepts in accelerating the Cheese ripening. Newer concepts of Cheese Rheology.

### DT-727 Advances in Fermented Milk Technology

Recent advances in the processing, manufacture, storage, packaging and utilization of various fermented milks. Biochemical changes occurring during manufacture of fermented milks, factors affecting these changes and effects of these changes on the quality of finished product. Innovations in starters used for fermented milks. Therapeutic value of fermented milks. Recent techniques for manufacture of yoghurt, acidophilus milk, cultured butter-milk, etc.

### DT – 999 Seminar

### **C.3 DAIRY ENGINEERING**

### **DE-708 Dairy Processing Equipment**

Metals and alloys use for dairy equipment, their composition, properties and uses, corrosion and its importance in dairy plant. Milk receiving equipment, weigh scale, dump tank, milk pump, can washer, etc., milk storage tanks. Milk pasteurizing equipment and related accessories, controls; cleaning; sanitary aspects of construction, operational care and maintenance. Cream separator, butter churn and homogenizer, their construction, operation and maintenance. Milk filling and packaging equipment, operation and maintenance. Condensing and drying plant for milk, accessories and equipment used, operation and maintenance control. Ice-cream manufacturing equipment, operation and maintenance. Cheese and casein manufacturing equipment. Maintenance schedule, organization of routine and preventive maintenance, purchasing of spares and store keeping records. Equipment for manufacture of indigenous dairy products. UF & RO plants.

### **Practicals:**

Studying complete set of milk receiving & storage equipments for their constructional, operational and maintenance details. Studying complete set of milk pasteurizing / sterilizing and related equipments. Studying complete set of fat handling equipments. Studying complete set of

# 3(3+0)

# 1(1+0)

4(2+2)

condensing / drying equipments. Studying complete set of ice-cream and frozen products equipments. Studying complete set of cheese and casein equipments. Visit to milk processing industry.

### **DE-709 Dairy Plant Services**

Steam generation, properties of steam, use of steam for cleaning, sterilization and processing, steam piping system, layout and controls, safety measures. Water supply system, pumps of different types, operational aspects, piping system for fresh water, chilled water, etc. fittings and controls, water requirement for cleaning and processing, system for disposal, economic use of water. Electricity for dairy plant, single and three phase supply, distribution system, wires, cables, switches, fuses and controls used, measuring of electrical power and energy used in processing. Utilization of electrical power for lighting, heating and operation of equipment, difference between single phase and three phase motors, starters, earthing and safety. Refrigeration systems commonly used, vapour compression system components, chilling of water, temperature control of deep freezer and cold stores, refrigerants used, operation of plant, servicing and maintenance, estimating cooling load for processing and cold store, insulation of pipes and cold store wall, construction of cold store, size and shape. Heat transfer in processing equipment, heat transfer coefficient, effect of surface film, fouling of surfaces, factors affecting heat transfer in different processes. Material handling, conveyors, hoists, augers, packaging of milk and milk products, transportation modes and economy of system. Boiler act & legal aspects.

### Practicals:

Detailed study of steam generating systems, their construction, operation & maintenance. Detailed study of steam supply & distribution systems. Detailed study of water treatment equipment. Detailed study of water supply & distribution. Detailed study of electricity supply & distribution. Detailed study of refrigeration plants. Detailed study of chilled water supply & distribution. Detailed study of compressed air generation, supply & distribution.

### **DE-720 Outlines of Dairy Engineering**

### 3(2+1)

4(2+2)

Unsteady state heat transfer, heat exchangers for dairy industry, construction, operation and maintenance of heat exchangers. Instrumentation for milk processing plants, flow meters, temperature and pressure measurement, properties of fluids affecting selection of controls, calibration of measuring instruments, automatic controls and their use in milk processing, cleaning etc. Unit operations such as filtration, mixing of liquids, mixing of solids with liquid, agitators, power consumption by different agitators, grinding of solids. Process equipment

19

design, selection of material, fabrication methods for mild steel and stainless steel, strength and stiffness of equipment, joints, gaskets etc. under actual working conditions, testing of completed pressure vessels, factor of safety in design, optimization in design of equipment, design of multiple effect evaporator and spray drying plant. Material handling in fluid milk plant, design and layout of different systems, cost considerations in material handling, systems for liquid and powder handling. Dairy building design and layout, chilling centres, fluid milk plant and product plant layout, estimation of services.

### **Practicals:**

Demonstration of various heat transfer models & equipment. Studying instrumentations of milk processing plants. Studying selected dairy plant machinery. Design calculations for selected process equipments. Studying material handling equipment. Studying building details & plant layout.

### **DE-729 Dairy Waste Disposal**

Unit operations in disposal and treatment of dairy waste, sedimentation and floatation, chemical and biological processes for treatment of domestic and industrial waste, sludge treatment and disposal, comparison of dairy waste disposal methods, design and layout of dairy waste disposal systems, environmental considerations.

### Practicals:

Study of effluent generation processes of the dairy products industry. Study of various treatment processes for dairy effluents. Characterization of selected effluents. Design calculations for specific effluent treatment systems. Visit to effluent treatment plants in dairy industry.

### DE-730 Energy Conservation in Dairy Plants

Conservation principles, prevention of losses, improving efficiencies, analysis of different conservation systems and comparison, conventional and non conventional sources of energy, system optimization, applications in dairy plants, co-generation, use of solar energy, heat pump, system analysis, improving component efficiencies and overall efficiency, reduction and quantification of waste, factors effecting energy needs such as size, site selection, location, schedule, environmental conditions, process parameters, and plant design, design considerations for organized and unorganized sectors, recent trends.

### Practicals:

Understanding of various energy utilizing operations in dairy industries. Identification of processes needing energy auditing. Calculations for energy auditing for selected processes. Studies on certain energy conservation devices & systems. Visit of dairy industry having co-generation or energy conservation systems.

20

### 3(2+1)

### **D. ALLIED COURSES**

### **MATH - 510 Advanced Mathematics**

Vector field, vector calculus, divergence and curl of a vector field, theorems of Gauss, Green and stokes in vector notation complex variable, elementary theory of analytical function, complex integration (Cauchy's integral formula). Power series expansions, Laurent expansion, singlularities, Residues, Schwars Christoffel transformation, Laplace transformations, tensors.

### AG. STAT.- 619 Design of experiments

Basic principles of Design of experiments. Uniformity trials - shape & size of plots and blocks. Elements of Linear estimation. Analysis of variance and Co-variance. CRD, RCBD and LSD. Factorial experiments, Confounding in 1<sup>n</sup>, 2<sup>n</sup> and 3<sup>n</sup> experiments. Split plot & Strip plot design. BIBD (general properties). Analysis of BIBD with recovery of inter block information, construction of BIBD. Variance stabilizing transformations, sampling in field experiments. Analysis of group of experiments. Switch over design - experimental on cultivator speed.

### Practicals:

Application of CRD, RCBD and LSD techniques to specific problems. Problems related to confounding. Problems related to variance and co-variance. Problems related to BIBD. Problems related to Switch over design.

### FPT – 921 Food Chemistry & Analysis

Nature and scope of food chemistry, Water in foods: types of water in foods and their specific functions, classification of foods on the basis of water; Carbohydrates in food: role and use of carbohydrates, chemical and functional properties of carbohydrates in food, starch and its modification, application in food and allied industries; Lipids in food: role and use of lipids in food, physicochemical properties of lipase, chemistry of rancidity, role of antioxidants, chemistry and technology of processing of fats and oils, and hydrogenation, effect of processing on functional properties and nutritive values of lipids; Proteins and Amino acids in food : physical and chemical properties of food proteins, functional and nutritional properties of proteins.

Principles of colorimetry and spectrophotometery, chromatographic techniques; electrophoresis, immunoelectrophoresis, isoelectric focusing, dialysis; ultra centrifugation, separation, purification

### 1(1+0)

3(3+0)

### 3(2+1)

and characterization of enzymes, proteins, carbohydrates and fatty acids; introduction to electron microscopic techniques.

### Practicals:

Study of different equipment & reagents for chemical analysis of foods. Determination of chemical composition of selected foods. Determination of lipid characteristics of selected products. Determination of protein characteristics of selected products. Quality analysis for specific product lines. Evaluation of on-line quality analysis of selected products. Visit to standard Food Testing Laboratories.

### FPT – 922 Food Microbiology & analysis

### 3(2+1)

3(2+1)

3(2+1)

Microbial spoilage of foods; Chemical changes caused by microorganisms. Principles of food preservation: asepsis, use of temperature controlled water activity, drying, radiation and pressure for control of micro organisms; Microbiology of various food products; Food fermentation technology; Different types of microbial species and their application in food processing.

### Practicals:

Study of different equipment & produces for microbiological analysis of foods. Identification of spoilage microbes and their isolation. Determination of microbial quality of selected food products. Studying food fermentation processes & equipment. Visit to good microbiological testing laboratory.

### FPT – 923 Bio Chemistry & Nutrition of Foods

Biochemical changes in food during post harvest operations: respiration, ripening, changes in colour, flavour, texture, changes in major constituents, changes in nutritional quality during storage; Browning effects in foods; Extraction and purification of enzymes;

Function of food ingredients in food system; energy value of food carbohydrates, fats and proteins and energy balance; Dietary functions and utilization of carbohydrates, fats, proteins, minerals and vitamins, balanced diet, dairy allowances and requirements of infants, children, adults, expectant and nursing mothers, concepts of malnutrition.

### Practicals:

Studying biochemical changes during post harvest handling of important food items. Extraction & purification of enzymes. Determination of nutritional quality of selected food products. Calculations for energy values of food constituents for various segments of consumers.

### FPT – 981 Computer Applications in Food Industry

Introduction of C++ language, input-output statements, concept of integer variable, arithmetic expression. The while, do while loops, the for loop, user defined functions, array, pointers, structures and file management in C++ language. Studies of engineering and statistical packages. A concept of data base management.

Networking and Communication: Basics of Analog and digital communication. Modems, multiplexes, networking topology, LAN, WAN and electronic mail. Introduction to Softwares like Auto CAD. Relational Database Management software. Elements & concepts concerning relational databases. Creating files - Adding records - Deleting/Editing records - Modifying file structure - Selecting searching of records data - Data manipulation and calculations within and across files - Report generation - Spreadsheets. "Modelling" for analysis/Forecast/Projections/Scheduling with electronic spreadsheets.

### Practicals:

Study of computer systems being used in food industry. Preparation of simple computer programmes for food industry. Study of available softwares & special packages relevant to food processing industry. Use of standard packages for real data of food industry. Use of graphic devices and preparation of specific graphics. Study of LAN / WAN systems. Visit to computer facilities in food processing industry.

### FPT – 982 Operation Research and MIS

Mathematical preliminaries, concept of optimization, methods of optimization, application of optimization techniques in agricultural engineering, system, non-linear system concept, classification of system, dynamic system, non-linear system and their analysis numerical solution of ordinary differential equations, time varying systems and their analysis.

3(3+0)