

**SEMESTER-WISE DISTRIBUTION OF REVISED COURSES OF B. TECH. (DT)**

## First Year (I Semester)

Course Code	Course Title	Credits	Contact Hours
DM-111	Fundamentals of Microbiology	3(2+1)	2+2
DC-111	Physical Chemistry of Milk	3(2+1)	2+2
DE-111	Workshop Practice	2(1+1)	1+2
DE-112	Fluid Mechanics	3(2+1)	2+2
MP-111	Milk Production Management & Dairy Development	3(2+1)	2+2
DE-113	Engineering Drawing	2(0+2)	0+4
ES-111	Economic Analysis	2(2+0)	2+0
CS-111	Computer and Application Software Packages	3(2+1)	2+2
EN-111	Environmental Studies	3(2+1)	2+2
	Total	24(15+9)	29(13+16)

## Ist Year (II Semester)

DT-121	Market Milk	4 (3+1)	3+2
DM-122	Introductory Dairy Microbiology	3 (2+1)	2+2
DE-124	Heat and Mass Transfer	3 (2+1)	3+2
DC-122	Chemistry of Milk	3 (2+1)	2+2
DE-125	Thermodynamics	3 (2+1)	2+2
DE-126	Electrical Engineering	3 (2+1)	2+2
BC-121	Biochemistry & Human Nutrition	3 (2+1)	2+2
	Total	25 (17+8)	34 (18+16)

2<sup>nd</sup> Year (III Semester)

DT-211	Traditional Dairy Products	4 (2+2)	2+4
DT-212	Ice-Cream & Frozen Deserts	4 (2+2)	2+4
DT-213	Fat-rich Dairy Products	4 (3+1)	3+2
DE-211	Refrigeration and Air Conditioning	3 (2+1)	2+2
DT-214	Cheese Technology	5 (3+2)	3+4
DE-212	Dairy Engineering	3 (2+1)	2+2
	Total	23(14+9)	32 (14+18)

2<sup>nd</sup> Year (IV Semester)

DT-225	Food Technology	4(3+1)	3+2
DT-226	Condensed & Dried Milk	5(3+2)	3+4
DT-227	By Products Technology	4(3+1)	3+2
DE-223	Dairy Process Engineering	3(2+1)	2+2
DT-228	Packaging of Dairy Products	3(2+1)	2+2
ES-221	Cost Accounting	2(2+0)	2+0
ES-222	Operations Research	2(2+0)	2+0
DX-221	Dairy Extension Education	2(1+1)	1+2
	Total	25 (18+7)	32(18+14)

**10 days educational tour during summer vacation after 2<sup>nd</sup> year.**

Third Year (V Semester)

CS-311	IT in Dairy Industry	3 (2+1)	2+2
DC-311	Chemical Quality Assurance	3 (2+1)	2+2
BT-311	Dairy Biotechnology	3 (2+1)	2+2
DM-311	Starter Cultures and Fermented Milk Products	3 (2+1)	2+2
DE-311	Instrumentation & Process Control	3 (2+1)	2+2
DM-312	Quality and Safety monitoring in Dairy Industry	3 (2+1)	2+2
ES-311	Financial Management	3 (2+1)	2+2
ES-312	Marketing Management & International Trade	2 (2+0)	2+0
DX-311	Communication Skills	2(1+1)	1+2
	Total	25 (17+8)	33 (17+16)

Third Year (VI Semester)

DE-322	Food Engineering	4 (3+1)	3+2
DE-323	Principles of Dairy Machine Design	3 (2+1)	2+2
DC-322	Food Chemistry	3 (2+1)	2+2
DM-323	Food and Industrial Microbiology	3 (2+1)	2+2
DE-324	Dairy Plant Design and Layout	3 (2+1)	2+2
DT-321	Judging of Dairy Products	3 (2+1)	2+2
DT-322	Dairy Plant Management & Pollution Control	2 (1+1)	1+2
ES-323	Entrepreneurship Development and Industrial Consultancy	2 (2+0)	2+0
ES-324	Financial Management	3 (2+1)	2+2
	Total	26 (18+8)	34(18+16)

Fourth Year: In-plant Training (VII and VII Semesters)

7

VII Semester		
	IN-PLANT TRAINING	25 (0+25)
	Total	25 (0+25)
VIII Semester		
	IN-PLANT TRAINING	25 (0+25)
	Total	25 (0+25)

## 1. DAIRY ENGINEERING

### DE-212 Dairy Engineering

3 (2+1)

Sanitization : Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system. Mechanical Separation: Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, Bactofuge, care and maintenance of separators and clarifiers. Homogenization : Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling bulk handling system, care and maintenance. Mixing and agitation : Theory and purpose of mixing. Equipments used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

**Practical :** To study : S. S. Pipes and fitting, gasket materials and S. S. milk pumps: Milk tanker and milk storage tanks: Can washer and bottles washer: C.I.P. Cleaning equipment: Homogenizers: Batch and Continuous pasteurizers: Different controls on pasteurizer: Different sterilizers: Pouch filling machine: Different types of agitators: Bottle filling and Capping machine: Determination of the rate of filtration and settling: Visit to a dairy plant.

### DE-223 Dairy Process Engineering:

3 (2+1)

Evaporation : Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators. Drying : Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers. Mechanization and equipment used in manufacture of indigenous dairy products, Butter and Ghee making machine, Ice-cream and Cheese making equipments. Packaging machines for milk & milk products. Membrane Processing : Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

**Practical:** Study of construction and operation of : Vacuum pan: Double effect evaporator: Spray dryer: Vacuum and atmospheric drum dryers. Study and operation of Butter, Ghee, Ice-cream and cheese making equipments, Study the Reverse Osmosis and Ultra filtration system: Design problems on Double effect evaporator and Vacuum pan. Visit to a milk product plant.

### DE-324 Dairy Plant Design and Layout

3 (2+1)

Introduction of Dairy Plant design and layout. Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout. Space requirements for dairy plants, estimation of service requirements including peak load consideration. General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design. Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop. Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility. Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout. Choice of building construction materials, floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows, Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants.

**Practical :** Building symbols and convention layouts for small, medium and large size dairies. Isometric presentation of piping. Design and layout of: Milk collection/chilling centre; Fluid milk plant (small, medium and large); Single product dairy (i) Cheese, (ii) ice-cream, (iii) butter and (iv) ghee. Composite dairy plant.

### **DE-311 Instrumentation and Process Control**

**3 (2+1)**

Absolute and secondary instruments, Types of secondary instruments, Essentials of indicating instruments, Constructional details of indicating instruments. Principle of induction type instruments- shaded pole method and two pole methods, compensation for frequency and temperature errors. Induction type voltmeter, Ammeter, advantage and disadvantages, induction type single phase watt hour meter , their errors and remedies, Numerical, wattmeter, power fractometer, etc. Characteristics of Instruments and Measuring Systems: Elements of generalized measuring system, static calibration, accuracy, sensitivity, reproducibility, static errors, dead zone, drift in measuring instruments. Analog and digital representation of signals, Factors influencing the choice of transducers. Mechanical Input Transducers: Level, Pressure, Flow, Velocity and Humidity- Resistive, Capacitive and Inductive, Dielectric system for humidity measurements. Temperature Transducers : Resistive, inductive, capacitive and thermoelectric transducer. Magnetic Transducers : Systems based on induction and magnetic effects on moving charges, Transducers based on permeability variation.

**Practical :** Preparation and calibration of thermocouple; study the construction and working of Bourden pressure gauge. Study the mechanism of pH meter and its electrodes. Study a pressure transducer. Study a Proximity sensor. Study of the different parts and working of Rotameter. Study the different parts and working of pressure switch. Study the different parts of an indicating instrument. Study the different parts and their working of single phase induction type watt-hour meter. Visit to a microprocessor controlled dairy plant.

### **DE-113 Engineering Drawing**

**2 (0+2)**

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale. Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of rivet heads, types of riveted; joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

### **DE-323 Principles of Dairy Machine Design**

**3 (2+1)**

Basic concepts in Statics and Dynamics. Force Systems. Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem. Dynamics : Equation of motion. Translation and rotation of a Rigid body, work and mechanics of materials : Stress-Axial Load classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio : Shearing Stresses. Torsion, Torsion formula, Angle to Twist of circular members. Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams. Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads. Machine Design : Procedures, Specification, strength, design factor, factor of safety selection of factor of safety. Materials and properties. Static strength, ductility, hardness, fatigue, designing for fatigue conditions. Theories of failure, Stresses in elementary machine parts, Design of a drive system. Design of length and thickness of belt. Bearing : Journal and Anti-friction bearings. Selection of ball, tapered roller and thrust bearing. Springs, helical and leaf springs. Energy stored in springs. Design and selection of springs.

**Practical:** Engineering Statics & Dynamics. Work and Energy. Linear and Angular Momentum. Stress-strain diagram evaluation of elastic constants. Power transmission. Shear force and bending moment diagrams. Flexural stresses. Shearing stresses in Beams. Fits and tolerances. Design stresses in elementary machine parts. Design of shafts, axles keys Springs, Couplings, Bearing

### **DE-111 Workshop Practice**

**2 (1+1)**

Introduction to workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry and pattern making. Mould material and their applications. Heat treatment processes: hardening, tempering, annealing, normalizing etc.

Metal cutting. Soldering & Brazing, Electric arc welding, Gas welding. Smithy and forging operations, tools and equipment. The bench : Flat surface filing, Chipping, Scraping Marking out, Drilling and Screwing. Use of jigs and fixtures in production. Introduction to following machine tools : (a) Lathe (b) Milling machine (c) Shaper and planer (d) Drilling and boring machines (e) Grinder (f) CNC machines

**Practical:** Simple exercises in Filing and Fitting, Chipping and Hack sawing, Chiseling, Tapping and Smithy practice, Simple exercises in Arc, Gas, & Argon welding. Simple exercises in Soldering, Brazing, Basic joints in carpentry

### **DE-112 Fluid Mechanics**

**3 (2+1)**

Units and dimensions, Properties of fluids. Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gages, Piezometer. Floating bodies: Archimedes principle, stability of floating bodies. Equilibrium of floating bodies. Metacentric height. Fluid flow: Classification, steady uniform and non uniform flow, Laminar and turbulent, continuity equation, Bernoulli's theorem and its applications. Flow through pipes: Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge. Dimensional analysis: Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. Pumps : Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Types of chambers, selection and sizing.

**Practical :** Study of different tools and fittings. Plotting flow rate versus pressure drop with U-tube manometer. Verification of Bernoulli's theorem. Determination of discharge co-efficient for venturi, Orifice, V-Notch. Verification of emptying time formula for a tank. Determination of critical Reynold's number by Reynold's apparatus. Study of reciprocating, centrifugal and gear pump. Calibration of Rota meter. Study of different types of valves. Problems on following topics: Pressure, capillarity and surface tension. Floating bodies, Liquid flow, venturimeter, orifice, weir, flow through pipes, pumps.

### **DE-124 Heat & Mass Transfer**

**3 (2+1)**

Basic heat transfer process, thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature. One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines. One dimensional steady state heat conduction with heat generation : Heat flow through slab, hollow sphere and cylinder with uniform heat generation, Development of equations of temperature distribution with different boundary conditions. Steady-state heat conduction with heat dissipation to environment :Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction. Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, Some important empirical relations used for determination of heat transfer coefficient. Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry. Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolar diffusion. Mass transfer co-efficient and problems on mass transfer.

**Practical:** Determination of thermal conductivity: milk, solid dairy & food products. Determination of overall heat transfer co-efficient of : Shell and tube, plate heat exchangers and Jacketed kettle used in Dairy & Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteuriser. Design problems on heat exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer

### **DE-125 Thermodynamics**

**3 (2+1)**

Basic concepts: systems, processes, cycles, energy, The Zeroth Law of Thermodynamics. Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, entropy, reversibility, availability. Air Cycles: Otto, Diesel, dual efficiencies, Plotting the cycles on various thermodynamic planes viz., p-V, T-S, p-h diagram; etc. IC. Engines: Two stroke and four stroke cycles, construction, injection and ignition of fuel, Performance of IC engines. Fuels: Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels. Renewable energy sources. Properties of steam: Wet, dry saturated,

superheated steam, Use of steam tables and Molier charts. Steam generators : Fire tube boilers, Water tube boilers. Boiler mountings and Boiler accessories. Draught : Natural, forced, fan, jet, Measurement of Height of chimney. Condensers. Layout of pipe-line and expansion joints. Boiler trial: Codes, Indian Boiler Regulation acts. Air Compressors: Reciprocating, Single and two stage air compressors.

**Practical:** Application of thermodynamics in engineering problems. Study of 2-stroke engine and 4-strokes engines. Performance tests on I.C. engines. Determination of dryness fraction of steam. To study the boiler installed in Model Plant, Water softening plant, Lancashire boiler, Locomotive boiler, Babcock & Wilcox boiler, Electrode boiler, Boiler mounting and steam-line layout and steam traps. Visit to sugar mill/rice mill or plant with steam utilization. Study of Solar water heater and biogas plants and appliances

### **DE-211 Refrigeration & Air Conditioning**

**3 (2+1)**

Basic refrigeration cycles and concepts : Standard rating refrigerating machines, Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors. Theoretical vapour compression cycle, Departure from theoretical vapour compression cycle, representation on T- and p-h diagrams, Mathematical analysis of vapour compression refrigeration system. Refrigerants: Primary and secondary refrigerants, common refrigerants (Ammonia, Freon), Brine, their properties and comparison. Multiple evaporator and compressor systems: Applications, One compressor systems: dual compression, comparison of system, Control of multiple evaporator system, Working and mathematical analysis of above systems. Refrigeration equipments: Compressor, Condenser, evaporator, Cooling tower, spray pond, Basic elements of design, Construction, operation and maintenance, balancing of different components of the system. Refrigeration Controls: Low side and high side float valves, capillary tube, thermostatic expansion valve, automatic expansion valve, solenoid valve, High pressure and low pressure cutouts, thermostat, overload protector, common defects and remedies. Refrigeration Piping: Purpose, materials, joint and fittings, water and brine pipe size selection. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Practical absorption system, Refrigerant absorbent combinations Absorption cycle analysis. Psychrometry: definition, properties of air-vapour mixtures, Psychrometric charts, Processes involving air vapor mixtures, Dehumidification, humidifiers, Humidity measurements, humidity control. Wet bulb, dry bulb temperature dew point temperature. Cooling load calculations: Types of loads, design conditions for air cooling, air conditioning loads. Cold storage: Types of cold storage, Types of loads in cold storage, Construction of cold storage. Insulating materials and vapour barriers.

**Practical :** Study of tools used in installation of a refrigeration plant including charging and detection of leaks. To study different parts and learn operation of bulk milk cooler. Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant. Study of different parts and learn the operation of a vapour absorption refrigeration plant. Dismantling and assemble an open compressor and a sealed unit. Study different parts and refrigeration controls of the following (a) Refrigerator (b) Water cooler (c) Deep Freezer (d) Compare their cooling coils and other systems. To find out the rating (cooling rate) at different suction temperatures (temperature differences) and air handling capacity of the air cooling unit. Plotting the practical refrigeration cycle on a pressure enthalpy diagram and to compare it with a theoretical refrigeration cycle. Study different parts and operation of a (a) Air washer, (b) Room cooler, (a) Air conditioner, (d) Chemical dehumidifiers, (e) Cooling. Plotting of psychrometric process: Sensible heating & cooling. Dehumidification & cooling and heating & humidification. Study of different humidity indicating, recording and controlling devices. Problems on cold storage. Visit to cold storage.

### **DE-126 Electrical Engineering**

**3 (2+1)**

Alternating current fundamentals: Electromagnetic induction magnitude of induced E.M.F. Alternating current, R.M.S. value and average value of an alternating current. Phase relations and vector representation. A.C. series and parallel circuits, Concept of resonance, polyphase alternating current circuits, three-phase concept, Star and delta connections, star delta transformation, Energy measurement. Transformers: Fundamental of transformer, Theory, vector diagram without load and with load, Losses, voltage regulation and efficiency of transformer, auto-transformer. Alternators: Elementary Principles, Construction and different types of alternators, E.M.F. in alternators, circuit breakers. Induction motors : Fundamental principles, production of rotating fields, construction, Rotor winding-squirrel cage and phase wound rotors, Analysis of current and torque, starting of induction motors, Motor housing, selection of motor and its controls. D.C. Machines: Construction and operation of D.C. generator, Types of generators, various characteristics of generator, D.C. motors, torque-speed characteristics of D.C. motors, Starting and speed control of D.C. motors. Electric Power Economics: Maximum demand charge, Load factor and power factor correction. Measuring Instruments: Classification of instruments, Elements of a generalized measurement system, static and dynamic characteristics.

**Practical:** Study of voltage resonance in L.C.R. circuits at constant frequency; (a) Star connection-study of voltage and current relation (b) Delta connection-study of voltage and current relation. Measurement of power in 3-phase circuit; (a) For balanced loads (b) For unbalanced loads, by wattmeter and energy meters. Polarity test, no-load test, efficiency and regulation test of single phase. Voltage and current relation in a 3-phase transformer of various kinds of primary and secondary connection systems. Starting of induction motor by the following starters : (i) D.O.L. (ii) Manual star- delta (iii) Automatic star-delta (iv) Manual auto-transformer. Starting of slip-ring induction motor by normal and automatic rotor starters. Test on 3-phase induction motor,



determination of efficiency, line current, speed, slip, power factor at various outputs. Determination relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristic of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Study of various measuring instruments.

### **DE-322 Food Engineering**

**4 (3+1)**

Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Viscoelastic models. Measurement of food texture. Food Freezing : Thermal properties of frozen foods. Prediction of freezing rates. Plank's equation, Neumann problem and Tao solution. Design of food freezing equipment, Air blast freezers, Plate freezers and immersion freezers, storage of frozen foods. Food dehydration : Estimation of drying time for food products, constant rate period and falling rate period dehydration. Diffusion controlled falling rate period. Use of heat and mass balanced in analysis of continuous dryers, fixed tray dehydration, cabinet drying, tunnel drying. Freeze Dehydration : Heat and mass transfer, Calculation of drying times, Industrial freeze drying. Equipment for pulping, Fruit juice extraction, Blanching, Dehulling, Size reduction and distillation.

**Practical:** Study of rheological properties of foods. Study of freezers and freeze dryers. Design problems on batch freezers. Design problems for continuous freezers. Design problems on dryer. Visit to cold storage. Visit to food processing plant.

## **2. DAIRY MICROBIOLOGY**

### **DM-111 Fundamentals of Microbiology**

**3 (2+1)**

Microbiology: history and scope; contributions of Leeuwenhoek, Pasteur and Koch. Principle of microbiology: Light Microscopy (Bright field, dark field, phase contrast, fluorescence); preparation and staining of specimens; electron microscopy. Microbial taxonomy: principles; numerical taxonomy; major characteristics used in taxonomy; classification according to Bergey's manual of systematic bacteriology. Structure and functions of prokaryotic cells; difference between prokaryotes and eukaryotes. Microbial growth and nutrition: the growth curve; factors affecting growth of microorganisms, estimation of bacterial growth; bacteriostatic and bactericidal agents; the common nutrient requirements and nutritional types of microorganisms. Bacterial genetics; DNA as the genetic material; structure of DNA; bacterial mutations (spontaneous and induced); genetic recombination- (transformation, transduction, conjugation). Micro flora of air, soil and water: methods for controlling microorganisms in air; water as carrier of pathogens.

**Practical:** General instruction for microbiological laboratory. Microscope- simple and compound; Microbiological equipments; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Mortality of microorganisms; hanging drop technique. Measurement of microorganisms by micrometry. Preparation of commonly used growth media liquid and solid: simple and differential media. Isolation technique for microorganisms- Streak & pour plate Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN).

### **DM-122 Introductory Dairy Microbiology**

**3 (2+1)**

Hygienic milk production system; microbial quality of milk produced under organized v/s unorganized milk sector in India and comparison with developed countries; microbial and non microbial contaminants, their sources and entry points in milk during various stages of production; Good Hygiene Practices (GHP) during milk production operations Microorganisms associated with raw milk; morphological and biochemical characteristics of important groups and their classification; significance of different groups of bacteria i.e. psychrotrophs, mesophiles, thermotolerants, and thermophiles in milk. Microbiological changes in bulk refrigerated raw milk; Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychrotrophic organisms; Direct and indirect rapid technique for assessment of microbial quality of milk. Role of microorganisms in spoilage of milk; souring, curdling, bitter cream, proteolysis, lipolysis; abnormal flavors and discoloration. Mastitis milk: Processing and public health significance, organisms causing mastitis, somatic cells secreted in milk; detection of somatic cell count (SCC) and organisms causing mastitis in milk. Milk as a vehicle of pathogens; Food infection, intoxication and toxic infection caused by milk borne pathogens like *E. coli*, *Salmonella typhi*, *Staph aureus*, *Bacillus cereus* etc. Antimicrobial substances in milk: immunoglobulin, lactoferrin, lysozymes, LP systems etc.

**Practical:** Morphological examination of common dairy organism (size and shape, arrangement and sporulation). Enumeration of psychrotrophic, thermophilic, thermotolerant and spore forming bacteria in milk. Detection of sources of contamination: air, water, utensils, equipment and personnel line testing. Spoilage

of milk caused by microorganisms souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discoloration. Detection of mastitis milks, pH, SLST, somatic cell count, chloride content, Hotis test, CAMP test. Detection and estimation of coliforms; presumptive test, rapid coliform count, IMVIC test. Detection of important pathogens using selective media; *E.coli*, *Staphylococcus aureus* *Salmonella* and *Bacillus cereus*. Estimation of microbial load in milk by SPC and Dye reduction tests-(MBRT, RRT). Detection of antibiotic residues using qualitative test

### **DM-323 Food and Industrial Microbiology**

**3 (2+1)**

Food Microbiology: Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in foods. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; control of spoilage. Food preservation : physical methods; chemical preservatives and natural antimicrobial compounds, biology based preservation system. Industrial Microbiology: Fermentation processes: the range, components and types (submerged, surface and solid state fermentation): criteria for selection of industrially important microorganisms; media for industrial and inoculums development; down stream processing of fermented products. Fermenters: types, functions, design and control; chemostat and turbidostat. Microorganism and processes involved in the production of industrial alcohol, organic acids (citric lactic), enzymes (protease, lipase and rennet), vitamin (B-12), antibiotic (nisin) and microbiology of effluent treatment in food industry.

**Practical:** Microbiological examination of: fresh and canned fruits/ vegetables/ juices; flour and bread, eggs and meat. Design and control of a tabletop and 10 liter lab fermenter (Demonstration). Isolation of psychrophile, salt and sugar tolerant microorganisms from foods. Isolation of industrially important microorganisms from environment. Production and assaying of microbial enzymes (protease/ lipase). Production of lactic acid from whey. Production of nisin and assaying the antimicrobial activity of the culture. Production of ethyl alcohol from molasses and whey by yeasts. Production of fermented whey beverages. Educational tour to food processing/ fermentation industries.

### **DM-311 Starter Cultures and Fermented Milk Products**

**3 (2+1)**

Introduction of starter cultures & their importance in dairy industry, classification of Lactic Acid Bacteria; Metabolism of Lactic Acid Bacteria and diacetyl production, production of antibacterial substances by lactic starter cultures. Mixed and define strain starter culture; propagation of starter cultures; factors affecting their propagation; starter concentrates- direct bulk and direct vat starter cultures; starter distillates. Quality and activity of starter cultures; defects in starters and their control; starter failures; antibiotic residues, sanitizers and bacteriophages. Preservation of starter cultures: freezing and freeze-drying; factors affecting the survival of cultures during preservation. Role of starter cultures in the preparation of various fermented milks; classification of fermented milks Microbiology of dahi and yoghurt; different types of dahi and yoghurt; preparation; defects and their control. Microbiology of milk products; their nutritional and therapeutic significance. Kefir and Kumiss: origin and characteristics: microbiology of Kefir grains. Microbiology of other fermented milks such as Bugarian milk, cultured buttermilk, Leben and Yakult; their significance. Concept of probiotic starters and their application in probiotic dairy food.

**Practical:** Testing for purity of starter cultures; gram's staining, catalase test; creatine test. Starter activity tests: die reduction tests, Horrall-Elliker test, Whitehead and Cox test. Preparation of single and mixed starter cultures: homofermentation and heterofermentation separately and also in combinations. Maintenance and preservation of starter cultures- Freeze drying techniques demonstration. Preparation of concentrated starter – freeze dried and frozen types. Effect of physical factors on dairy starter: temperature, pH, salt, sugar. Testing milk for the presence of inhibitory substance using *B. stearothermophilus* and *S. thermophilus* as indicator organisms. Effect of antibiotic residues in milk on starter activity. Associative growth of microorganisms in milk and cream. Detection of bacteriophages in cheese whey by plaque assay. Preparation and evaluation of quality and grading of Dahi, Yoghurt, cultured butter milks, acidophilus milk and Kumiss. Microbiological analysis of processed cheese- Total spore count & Anaerobic spore count. Microbiological analysis at different stages of manufacture of (storage and ripening) hard varieties of cheese- such as Cheddar cheese.

### **BT-311 Dairy Biotechnology**

**3 (2+1)**

Definition, scope and historical development of biotechnology, achievement and future application: structure of DNA and RNA; DNA replication, protein synthesis, genetic code, mutations: Vectors, cloning strategies in bacteria and animals, DNA technology. Protoplast fusion & Tissue culture in dairy cultures. Application of biotechnology in food and dairy industry, dairy effluents. Genetic manipulation of dairy starters for improved attributes of commercial value. Dairy enzymes and whole cell immobilization. Ethical issues related to use of genetically modified foods.

**Practical :** Isolation of plasmid and genomic DNA from bacteria (*E. coil*, lactic acid bacteria Agarose gel electrophoresis of DNA fragments). Restriction analysis of DNA. Curing of plasmids. Preparation of competent

cell. Conjugal transfer in *E. coli* cells. Transformation of *E. coli* by calcium chloride treatment/ electro oration. Preparation of protoplasts and protoplast fusion. PCR technique demonstration. Visit to a biotechnology lab.

### **DM-312 Quality and Safety Monitoring in Dairy Industry**

**3 (2+1)**

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentarius commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration Principles in detection of predominant spoilage organisms and pathogens like indicator organisms, *E.coli*, *salmonella*, *shigella*, *staph aureus*, *Bacillus cereus* and non microbial contaminants like antibiotic residues, aflatoxin, pesticides other inhibitors etc from. dairy foods and their control measures. Microbial quality of water and environmental hygiene in dairy plant; chlorination of dairy water supply, quality of air. Personnel hygiene, treatment and disposal of waste water and effluents; setting up of a microbiological/ pathogen lab in a dairy plant and its safety concern.

**Practical :** Evaluation of common sanitizing agents used in dairy plants by a) suspension b) capacity test. Microbiological tests for assessing equipment and personnel hygiene by swap and rinse methods. Detection of faecal and non- faecal coliforms and faecal streptococci in dairy plant. Detection and enumeration of different pathogenic bacteria in dairy products: *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* and *Shigella*. Bacteriological analysis of dairy water for : a) total viable counts b) coliform counts (MPN). Detection of antibiotic residues, pesticides, aflatoxins and staphylococcal enterotoxins in milk using rapid techniques. Determination of BOD in dairy waste water. Quality evaluation by HACCP in the preparation of dairy products.

## **3. DAIRY TECHNOLOGY**

### **DT-121 Market Milk**

**4 (3+1)**

Market milk industry in India and abroad: Distinctive features of tropical dairying as compared to those of the tropical climate of developed countries. Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitors, lactoperoxidase system. c) Microbial quality of milk produced on farm. Effect of pooling and storing on microbial quality of refrigerated milk. Role of psychrotrophs, Role of tropical climate on spoilage of milk.d) Chemical tests for grading raw milk. e) Microbio- logical tests for grading raw milk. Reception and treatment (pre-processing steps) of milk in the dairy plant: a) Reception, chilling, clarification and storage: General practices. b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) c) Effect of homogenization on physical properties of milk. d) Bactofugation: Theory and microbiology. Thermal processing of milk: a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, arrhenius equation, D value, Z value, F<sub>0</sub> value, Q<sub>10</sub> value. b) Factors affecting thermal destruction of micro-organisms. c) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing. d) Microbiology of pasteurised milk, thermozes, sterilized & UHT milk. e) Product control in market milk plant. f) Defects in market milk. g) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized vitaminised and sweet acidophilus milk. h) Manufacture of sterilized milk. i) Distribution systems for market milk. Quality and safety aspects in dairy food chain, good manufacturing practices (GMP) in dairy processing. UHT processing of milk : a) Relevance of UHT processing in the tropical climate b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants. c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems. d) Technical control in the UHT plant. Training of personnel. Plant hygiene. e) Shelf life of UHT milk and tests for UHT milk. Nutritive value of milk. Effect of heat processing on nutritive value. Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency. Maintaining plant hygiene & HACCP.

**Practical :** Familiarization with equipments for reception of milk in plant; Pretreatments: Chilling, clarification, filtration. Standardization and numericals relating to it. Cream separation: parts of separator and the process. Operation of LTLT, HTST pasteurizer, laboratory steriliser. Sampling and chemical examination of pasteurized, sterilized and UHT processed milk. Sampling and routine microbiological examination of microbiological examination of pasteurized and sterilized milk. Preparation of special milks; toned, double toned, standardised, flavoured, sterilised. Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP. Detection of adulterants and preservatives in milk. Assessment of homogenisation efficiency in milk. Strength of common detergents and sanitizers used in market milk plant.

### **DT-211 Dairy Products**

**3 (2+1)**

Status and significance of traditional milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation factors affecting yield of khoa. Physico-chemical changes during manufacture and storage of khoa. Mechanization in manufacture of khoa. Confectioneries made from Khoa-Burfi, peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundhi: Product identification, process description, factors affecting yield physico-chemical changes during manufacture. Chhana: Product description, Standards method of manufacture, packaging and preservation. Chhana-based sweets, Rasogolla, Sandesh, Ras-malai. Mechanization of manufacturing process. Paneer: Product description standards method of manufacture packaging and preservation. Physico-chemical changes during manufacture and storage. Mechanization of paneer manufacturing/packaging process. Srikhand: Chakka-product description, standards method of manufacture, small scale and industrial, packaging and preservation aspects. Shrikhand-save as chakka. Physico-chemical changes and quality assurance during manufacture and storage. Sandesh: Product description method of manufacture and packaging process. Misti dahi : Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Microbiology of indigenous milk products, predominance of spoilage & pathogenic organisms in Khoa, Chhana, Paneer, Shrikhand, their spoilages, control measures & legal specifications. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

**Practical :** Preparation of khoa from cow, buffalo and concentrated milk. Analysis of khoa, chhana and paneer for total solids, moisture, fat and acidity. Preparation of kheer. Preparation of chhana from cow and buffalo milk and mixed milk. Preparation of paneer from cow and buffalo milk and mixed milk. Preparation of misti dahi, chhaka and srikhand. Preparation of khoa and chhana based sweets. Microbiological examinations of traditional dairy products: Khoa, paneer, spore counts, coliform counts yeast, molds counts etc. Field trip

#### **DT-213 Fat-Rich Dairy Products**

**4 (3+1)**

Status of fat-rich dairy products in India and abroad. Cream: a) Definition & Legal standards, Efficiency of cream separation and factors affecting it; control of fat concentration in cream. b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. d) Bacteriology of cream including defects, factors affecting quality of cream; ripening of cream e) Packaging storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: a) Introduction to the butter making process; theory of churning, Legal standards. b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat losses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Microenvironment in cream and butter, impact of critical process factors on entry of spoilage and pathogenic organisms in cream & butter, their spoilages & control measures. Legal microbiologies specifications of cream & butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butterchurn and continuous butter making machine. Special butters and related products:a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter / fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. b) Manufacture, packaging, storage and characteristics of margarine of different types.Ghee and butter oil: a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. b) Ghee: Composition and changes during manufacture fat constants.

**Practical:** Microbiological examination of cream:Direct microscopic count, Dye reduction tests. Microbiological examination of cream: a)Total viable count b)Lipolytic count c) Coliform count. Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand-operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn.Preparation of ghee from cream and butter. Study and operation of continuous ghee plant. Sampling, determination of melting/slip point, moisture by gravimetric method, B.R. Index and Baudouin Test. Acidity, Helphen Test for the presence of cotton-seed oil. R.M. value and Polenske value. Saponification value. Iodine value. Peroxide value. Detection of animal body fats and vegetable oils. Examination of the quality of sodium chloride for butter making

#### **DT-214 Cheese Technology**

**5 (3+2)**

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese. Milk quality in relation to cheese making. Treatment of milk; Physical and chemical. Cheese additives and preservatives. Role of starter culture in relation to cheese quality. Rennet preparation and properties, rennet substitutes. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage.Microbiological

changes during preparation ripening in cheese. Role of milk constituents and changes during manufacture and ripening in cheese. Factors affecting yield of cheese. Packing, storage and distribution of cheese. Accelerated ripening of cheese. Microbiological defects in cheese; their cause and prevention. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing. Microbiological critical control of cheese cold store.

**Practicals:** Familiarization with equipments, accessories and standardization numericals. Study of factors affecting rennet action. Manufacture of Cheddar cheese. Manufacture of Gouda cheese. Manufacture of Mozzarella cheese. Manufacture of Swiss cheese. Manufacture of Cottage cheese. Manufacture of Processed cheese. Manufacture of Processed cheese spread. Manufacture of processed cheese food. Analysis of cheese; proximate composition. Determination of ripening index

**DT-212 Ice-Cream And Frozen Desserts****4 (2+2)**

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition of ice cream and other frozen desserts, Stabilizers and emulsifiers-their classification, properties and role in quality of ice-cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant, Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention, Physico-chemical properties of ice-cream and compositional standards., Microenvironment in ice cream, microbiological quality of ingredients, critical process factors & their impact on entry of pathogen in ice cream, their survival during storage, food poisoning outbreaks, food safety & legal standards, Recent advances in ice-cream industry and plant management, Technology for preparation of dried ice-cream milk mix. and Nutritive value of ice-cream.

**Practical:** Calculation of standardization of ice-cream mixes. Manufacture of plain and fruit flavoured ice-cream. Manufacture of chocolate, fruit and nut ice cream. Preparation of sherbets/ices. Preparation of soft served and filled ice-cream. Manufacture of kulfi. Study of continuous and batch type freezers. Manufacture of ice-cream by continuous process. Compositional analysis of ice-cream. Microbiological examination of ice-cream and other frozen desserts; SPC, coliform, staphylococci & Salmonella. Field trips.

**DT-226 Condensed And Dried Milk****5 (3+2)**

History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk., Manufacturing techniques;a) Manufacture of evaporated milk including pilot sterilization test b) Manufacture of sweetened condensed milk c) Recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk, Physico-chemical properties of condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention., Microbiological qualities of condensed milks, preservative used in evaporated, condensed & dried milks, a) Type of microorganisms occurring in condensed milks b) Survival and growth of microorganisms during manufacture and storage.c) Microbiological standards, d) Type of spoilage and their prevention. Recent advances with reference to freeze concentration and membrane concentration, Dried Milks: History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk, Manufacture of infant foods, malted milk foods and other formulated dried products, Microbiological quality of various dried milks including infant foods and Management of condensed and dried milk industry.

**Practical :** Manufacture of plain skim concentrated milk. Chemicals and microbiological examination of concentrated and dried milks for (a) Moisture, T.S., Fat, lactose, sucrose, bulk density, solubility index, and (b) SPC, coliforms, yeasts and molds, toxins etc. Manufacture of SCM. Manufacture of EM. Concentration of milk by membrane processing. Manufacturing of SMP by spray drying/roller drying. Manufacture of instant milk powder.

**DT-227 By Products Technology****4 (3+1)**

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems., Physico chemical characteristics of whey, butter milk and ghee residue, By-products from skim milk: a) Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. b) Industrial and food uses of caseins c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications d) Manufacture of casein hydrolysates and its industrial application e) Coprecipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications. Whey processing: a) Fermented products from whey, b) Beverages from whey c) Deproteinized and demineralized whey d) Condensed whey e) Dried whey, types and their specification, manufacturing techniques. f) Utilization of whey products. Whey protein concentrates: a) Methods of isolation with basic principles involved, physico-chemical properties of whey protein concentrates b) Functional properties and food applications of WPC. Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: a) Condensed butter milk b) Dried butter milk c) Utilization of butter milk products Ghee residue. Composition, processing and utilization. Nutritional characteristics of by products.

**Practical:** Manufacture of edible casein from cow and buffalo milk. Manufacture of rennet casein. Manufacture of sodium caseinate. Manufacture of calcium caseinate. Manufacture of coprecipitate. Chemical analysis of

whey, buttermilk, casein, casein and co-precipitates. Isolation of whey proteins by cold precipitation technique. Manufacture of whey proteins, concentration by ultra filtration process. Manufacture of whey drinks. Manufacture of dried whey. Manufacture of lactose. Chemical analysis of whey protein concentrates and lactose. Microbiological analysis of casein and dried whey. Incorporation of whey protein concentrates in processed cheese foods. Manufacture of coffee whitener.

### **DT-321 Judging of Dairy Products**

**3 (2+1)**

Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects; factors affecting food acceptance. Terminology related to sensory evaluation. Design and requirements of sensory evaluation laboratory.

Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Fundamental rules for scoring and grading of milk and milk products. Procedure: Types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests. Panel selection, screening and training of judges. Requirements of sensory evaluation, sampling procedures. Factors influencing sensory measurements. Milk: Classes of raw and processed milks, defects associated with them; milk score card and its use. Judging and grading of milk. Fermented milks: Desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks. Cream: Desirable attributes and defects in cream, Score card for cream, Judging and grading of different types of cream. Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter. Ghee: Grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee. Frozen dairy products: Desirable and undesirable characteristics of frozen dairy products. Sensory evaluation of ice cream, kulfi and milk sherbets. Cheese: Quality attributes of some common cheese varieties and their defects, score card for cheese. Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses. Dried dairy products: Desirable and undesirable characteristic of dried milks. Judging and grading of dry milk products. Concentrated milks: Desirable attributes and defects. Judging and grading of evaporated and condensed milk. Heat desiccated Indian milk products: Desirable and undesirable characteristics. Sensory evaluation of khoa and khoa based sweets. Acid coagulated Indian milk products: desirable and undesirable characteristics. Sensory evaluation of paneer, chhana and chhana based sweets. Consumer acceptance studies: Objectives. Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations. Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests. Preparation of milk and milk products with defects, techniques for simulation.

**Practical:** Determination of threshold value for basic tastes. Determination of threshold value for various odours. Selection of judging panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests. Judging of milk and cream. Judging of butter and ghee. Judging or condensed and evaporated milk. Judging of milk powders. Judging of cheese and related products. Judging of frozen products. Judging of khoa and khoa-based sweets. Judging of chhana and chhana based sweets. Judging of dahi and fermented dairy products.

### **DT-225 Food Technology**

**4 (3+1)**

Status of food processing industries in India and abroad, magnitude and inter-dependence of dairy and food industry, prospects for future growth in India. Harvesting, transportation and storage of fruits and vegetables. Post harvest processing of fruits and vegetables. Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables. Juice processing- General steps in juice processing, role of enzymes in fruit. Juice extraction, equipments and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders. Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices. Jam, Jelly, Marmalade, Pectin: & technology. Fruits and vegetable preserves, Glazed, Crystallized fruits. Tomato base products: Juice, puree, paste, sauce, ketchup. Pickles: Principle of pickling, technology of pickles. Beverages – Classification, scope, carbonated non-alcoholic beverages and its manufacture. Fruit beverages and drinks, additives for fruit based beverages. Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee. Tea- Tea leaf processing, green, red, yellow, instant tea. Technology of confectionery foods- Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products. Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products. Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

**Practicals:** Manufacture of toffees and caramels, Testing the efficacy of blanching process, Drying of fruits and vegetables, Preparation of fruit based drinks and beverages: Ready-to-serve drink, Nectar, Squash, Whey-fruit based beverages. Manufacture of fruit jam. Manufacture of fruit jelly. Manufacture of chocolate confections. Manufacture of tomato ketchup/tomato sauce. Manufacture of soups. Manufacture of fruit preserve. Manufacture of candied fruits. Manufacture of fruit bar. Manufacture of pickles

**DT-228 Packaging Of Dairy Products****3 (2+1)**

Introduction, Importance of Packaging, History of Package Development, Packaging materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeats, concentrated and dried milks including baby foods. Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems.

**Practical:** Identification of packaging materials, Flame Hot wire test, Testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength. Testing of glass bottle – resistance to thermal shock. Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance. Packaging of different dairy products by using prepak and vacuum packaging machines. Microbiological evaluation of packaging materials (SPC, Y & M, spore count).

**DT-322 Dairy Plant Management And Pollution Control****2 (1+1)**

Production Management. Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement motion and time study, Plant Operations. Efficiency factors losses, Financial and Managerial efficiency Provision for Industrial Legislation in India, Particularly in dairy industry, Personal Management. Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions. Safety hazards, hazards prevention security for plant machinery and the employees, Plant Maintenance. Prevention & Break-down maintenance Spare parts inventory, tools & lubricants etc. Food hygiene, personnel hygiene, plant hygiene, water quality etc. Cleaning and Sanitation – different type of cleaning and sanitizing agents, Effluent treatment: Type, degree and treatment of waste.

**Practical :** Flow process charts of different milk products. Identification of steps of material losses on Dairy plants. Identification of hazardous processes and equipments, safety and precautions. Identification and uses of common lubricants. Waste Utilisation processes. Various treatments in waste disposal. Analysis of cleaning agents and sanitizers. Reports and records maintenance of dairy plant. Operational precautions. CIP cleaning

**4. DAIRY CHEMISTRY****DC-111 Physical Chemistry of Milk****3 (2+1)**

Constituents and gross composition of milk of different species and breeds of milch animals, Colloidal State : Distinction between true and colloidal solution, lyophilic & lyophobic solution, properties of colloidal system. Properties of colloidal systems, Gels-their formation and properties. Milk as a colloidal system and its stability. Elementary idea about emulsion. Density : Density and specific gravity, pycnometer method, hydrometer lactometer. Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk. Liquid State : Surface tension, surface energy interfacial tension. Surface tension of mixtures. Surface tension of milk and the factors affecting it. Viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Refractive index. Colligative Properties of Dilute Solution : Vapour pressure, Raoult's Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk. Osmosis and Osmotic pressure. Inter-relation of colligative properties. Aqueous solution of Electrolytes : Electrolytes ; non-electrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrausch Law, Electrical conductance of milk. Ionic Equilibria : Dissociation of water, ionic product of water, concept of pH and pOH and their scale. Acids and bases : Bronsted Lewis concepts of acids and bases, dissociation constants of acids and bases. Salt-their hydrolysis. Buffer solutions. Derivation of Henderson – Hasselbach equation and its application, buffer capacity and buffer index, milk as a buffer system. Equilibrium of electrolytes. pH indicators. Oxidation- Reduction : Redox potential, Nernst equation, electrochemical cells. Hydrogen, glass and calomel electrodes. Redox system of milk. Nuclear Chemistry : The nature of isotopes, radio isotopes. Half life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclide in milk & milk products. Molecular Spectroscopy : The spectrum of electro magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscopy. Mention of mass, NMR spectroscopy.



**Practical:** Determination of density and specific gravity of milk using pycnometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

### **DC-122 Chemistry of Milk**

**3 (2+1)**

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins, Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins:  $\alpha$ -Lactalbumin and  $\beta$ -Lactoglobulin. Properties of  $\alpha$ -Lactalbumin and  $\beta$  lactoglobulin, Immunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins, Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase, Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose, Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins, Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

**Practical:** Sampling techniques of chemical examination of milk. Determination of pH and titratable acidity of milk. Determination of fat in milk by different methods. Determination of total solids and solids not fat in milk. Determination of total milk proteins by Kjeldahl method. Determination of casein, whey proteins and NPN in milk. Estimation of alkaline phosphatase and lipase in milk. Determination of lactose in milk. Determination of ash in milk. Determination of phosphorus and calcium in milk. Determination of chloride in milk. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

### **DC-311 Chemical Quality Assurance**

**3 (2+1)**

Importance of chemical quality control in dairy industry ; setting up quality control laboratories and testing facilities: mobile testing laboratories. Sampling procedures ; labeling of samples for analysis : choice of analytical tests for milk and milk products for chemical analysis; instrumental methods of analysis. Calibration of dairy glassware including butyrometer, pipettes, burettes, hydrometers, lactometers and freezing point thermometer. Preparation and standardization of reagents required in the analysis of milk and milk products. Application of PFA, AGMARK, BIS and codex related to dairy products for the quality control of milk and milk products. Preservatives, neutralizers and adulterants in milk and milk products and their detection. Accreditation of analytical laboratories ; Hazard analysis and critical control points (HACCP). Prediction of shelf life behavior of milk and milk products. Milk contact surfaces, metallic contamination, environmental contaminants such as pesticides, antibiotics, heavy metals in dairy products: methods of estimation. Soft and hard water, temporary and permanent hardness, softening of hard water.

**Practical :** Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings. EDTA solutions etc. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Analysis of market samples of milk and milk products.

### **DC-322 Food Chemistry**

**3 (2+1)**

Water: Water binding and chemical reactions mediated by water. Food Proteins: Classification, physico-chemical properties, Reaction involved in processing, Reactions with alkali, Enzyme catalysed reactions involving hydrolysis and proteolysis, Theories of formation of texturised proteins. Lipid : Reactions involved during deep frying of food viz., autoxidation of saturated acyl lipids and polymerization. Lipoprotein and membrane ; definition, classification and involvement in the formation of biological membranes. Unsaponifiable matter contents in various fats and oils. Edible fats and oils, classification and chemical composition. Carbohydrates: Legumes, jellies polysaccharide viz. linear, branched and modified. Properties and utilization of common polysaccharides, viz. cellulose, glycogen, hemicellulose and pectin. Enzymatic degradation of polysaccharides, viz. agar, alginate. Carrageenan, 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 foods: 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-monosodium glutamate, nucleotides. Sugar substitutes, sorbitol. Sweeteners-saccharin, cyclamate. Food colours. 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. Type of flours, bread making and non-bread making: chemical composition, influence of additives/minor ingredients on baking properties. Physical, chemical changes during baking. Legumes : Classification composition and physico-chemical properties. Vegetables and fruits : 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.

**Practical:** Determination of moisture, acidity and gluten content in flour. Determination of total ash and acid insoluble ash in flour. Determination of starch in flour. Determination of total nitrogen in cereal products. Determination of acidity and vitamin C in citrus fruits. Analysis of tomato ketchup for total solids, acidity, ash and salt. Determination of total sugar in tomato ketchup. Determination of total ash and alkalinity of soluble ash in tea. Determination of water extractive in tea leaves. Determination of presence of Chicory in coffee powder. Determination of reducing sugars in Jam. Determination of iron in infant foods.

## 5. BIOCHEMISTRY

### BC-121 Biochemistry & Human Nutrition

3 (2+1)

*Biochemistry:* Enzymes Ribozymes, isozymes, allosteric enzymes, zymogens, regulatory, Classification and mechanism of enzyme action, Factors affecting rate of enzyme catalyzed reaction, enzyme inhibition, Enzymes coenzymes and co-factors immobilization of enzymes, Nucleic acids and Bioenergetics : Structure and function, definition and composition. Structure of RNA & DNA-Anabolism and Catabolism of carbohydrates, lipids and proteins. Vitamins and Hormones : Structure & functions, general description. Relationship between vitamins and hormones in terms of their biological role. Elementary knowledge of milk synthesis in mammary gland.

*Human Nutrition:* Theory and definition, Scope of Nutrition : Functions of the various nutrients in body. Digestion, absorption and assimilation of nutrients. Comparative requirements and nutritional requirement of different age groups. (WHO and ICMR standard) Methods of evaluation of nutritive value of foods Nutritional value of cow, buffalo and human milk. Milk intolerance: lactose deficiency and protein hyper sensitivity. Safety aspects of food additives, toxic elements, radionuclides, pesticides and antibiotic residues in milk and milk products. Institutional feeding of workers. Planning and implementation of national food and nutrition policies and programme. Regulatory aspects of nutrition, IDF code on nutrition, nutrition facts under NLEA, Nutrient descriptors, serving size and nutritional claims.

**Practical:** *Biochemistry* Estimation of alkaline phosphatase and the effect of temperature and pH on its activity. Estimation of catalases and the effect of temperature and pH on its activity. Determination of the Michealis constant of an enzyme. Estimation of RNA by colorimetric method Estimation of DNA by colorimetric method. Measurement of proteolysis. Lipolysis, Amylase activity. Estimation of vitamin 'A; in ghee. Estimation of ascorbic acid in milk. Estimation of vitamin D in milk. Estimation of proteins by Lowry's method. Buret method. Estimation of Lipids and Lipids analysis by TLC. Estimations of cholesterol in milk. Estimation of denaturation of proteins in heated milk by dye binding method. Estimation of HMF content in food.

## 6. DAIRY ECONOMICS STATISTICS AND MANAGEMENT

### ES-111 Economic Analysis

2 (2+0)

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors. Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus. Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns. Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale. Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition. National income – GDP, GNP, NNP, disposable personal

Income, per capita income, inflation. Economic features and characteristics of dairy sector in India. Dairy development strategy with special emphasis in post- independence era and Operation Flood Programme

### **ES-112 Industrial Statistics**

**3 (2+1)**

Definition and scope; sources of animal husbandry and dairy statistics. Measures of central tendency, Measures of dispersion, Moments, skewness and kurtosis.

Elementary notions of probability, Laws of addition and multiplication probability. Theoretical frequency distributions: Binomial, Poisson and Normal distribution and their application. Concepts of sampling methods,

Introduction to testing of hypotheses, Tests of significance-Z, t,  $\chi^2$ , F tests, and their application in the field of dairying. Analysis of variance- One-Way and two-way classification. Simple correlation coefficient and its test of significance, Linear regression, rank correlation. Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

**Practical:** Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis Fitting of binomial and Poisson distribution. Application of 'Z' test for one and two sample problems. Application of 't' test for one and two sample problems. Application of Chi-square test and F-test. Correlation and regression. Rank correlation coefficient. Control chart for variables & attributes

### **ES-221 Cost Accounting**

**2 (2+0)**

Introduction, definition, objectives, common terms Costing: Essentials of sound costing system. Different methods of costing, elements of cost.

Labour: Recording of time, idle time, methods of remunerating labour. Premium & bonus plans Materials, Overheads. Cost Classification: Direct and indirect expenses, fixed and variable costs. Various methods of apportioning indirect expenses. Inventory management: Planning, control and costing. Stores & store-keeping, scope & importance. Purchase procedure, types of purchase, location of stores & materials, procedure for the movement of stores, different methods of pricing materials, store records. Cost Sheets : Different methods, statement of cost and statement of profit. Estimates, Tenders / Quotations. Contract / Terminal costing. Process Costing: Process losses and inter-process profits, joint products and by-products costing. Ascertainment of cost of milk production. Preparation of cost accounting information for managerial decisions

### **ES-222 Operations Research**

**2 (2+0)**

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making. Modeling in Operation Research. Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems.

Inventory Control – Introduction and general notations, Economic lot size models with known demand.

Replacement – Introduction, Replacement of items whose efficiency deteriorates with time.

Queuing – Introduction and general notions, Classification of queues and their problems, Probability distribution of queues. Various models in the queuing system.

Sequencing – Statement of the problem, notations and assumptions, Problems with 'n' jobs and two machines, Generalization to 'm' machines.

Transportation model – Definition and application of transportation model, Formulation of transportation problems and their solutions

Assignment problems and their solutions. Framework of PERT and CPM, Activities, events and network, PERT and activity time estimates, probability of project completion Critical path analysis.

### **ES-311 Financial Management**

**2 (2+1)**

Introduction: Definition, scope and objective of financial management, common concepts & terms. Book-keeping and Accounts: different systems of accounting; Double entry system of book-keeping; Preparation of accounting records- original records, posting in ledger, cash book, etc., classification and final accounts; adjustments at the end of trading period, preparation of trial balance; banking transactions and bank reconciliation statements.

Statements of Financial Information: Accounting system- a source of financial statements, classification of capital and revenue expenditure; balance sheet, profit and loss account, statement of changes in the financial position; funds flow statement, cash flow statement and their use in financial decision making.

Depreciation: concepts and methods

Capital structure: capital structure and financial structure, capital structure planning, risk return trade off, financial leverage, portfolio analysis and risk diversification.

Financial Analysis: Nature and uses of financial analysis, Ratio analysis such as structural ratios, Liquidity ratios, profitability ratios, Activity ratios, turnover ratios, leverage ratios, utility of ratio analysis; CVP analysis and utility of CVP analysis; break even analysis; profit and operating analyses.

Capital budgeting/ investment decisions: Capital investment decisions, measurement of cash flow; Time value of money, payback period, average return on investment, accounting rate of return, net present value and internal rate of return, profitability index;

Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital & retained earnings; overall cost of capital; investment decision making- investment timing and duration, investment during inflation and capital rationing.

Complex investment decisions, investment timing & duration, investment under inflation and Capital rationing.

Working capital management: Concept and determinants of working capital, estimating working capital needs; approaches to working capital management- management of cash, marketable securities and inventory management.

**Practicals:** Recording and classification of business transactions, Financial statements- balance sheet, profit and loss account, income statement, Depreciation, Cash flow statement, Ratio analysis, Analysis of financial statements, Cost of capital, Capital budgeting and investment decisions, Break-even analysis

### **ES-323 Entrepreneurship Development and Industrial Consultancy 2 (1+1)**

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business.

**Industrial Consultancy:** Dairy plant management system- milk procurement from the rural milk producer, milk processing and products manufacturing. Pricing and marketing of milk and milk products. Survey on milk production potential and marketed surplus of milk for setting up of milk plants. Recruitment and training of manpower, Estimation of costs of product manufacture and energy utilization in food processing plants. Sources of finance for setting up of dairy farms and processing plants/ units. Guidelines for obtaining ISO/HACCP certification for dairy plants.

**Practicals:** Assessment of entrepreneurial skills and characteristics for successful entrepreneur. Consumer opinion surveys. Pricing of milk and milk products. Preparation of feasibility reports for setting of dairy farms, composite milk plants, collection centers, chilling units and processing units.

**ES-312 Marketing Management and International Trade****2 (2+0)**

Concept of marketing ; Functions of marketing ; concepts of marketing management ; scope of marketing management ; marketing management. Process ; concepts of marketing- mix, elements of marketing- mix. Market Structure and Consumer Buying Behaviour: Concept of market structure, marketing environment, micro and macro environments. Consumers buying behaviour, consumerism. Marketing Opportunities Analysis: Marketing research and marketing information systems; Market measurement- present and future demand ; Market forecasting; market segmentation, targeting and positioning. Allocation and marketing resources. Marketing Planning Process. Product policy and planning : Product-mix; product line; product life cycle. New product development process. Product brand, packaging, services decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing Decisions. Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising; How advertising works; Deciding advertising objectives, advertising budget and advertising message; Media Planning; Personal Selling, Publicity; Sales Promotion. Food and Dairy Products Marketing. International Marketing and International Trade. Salient features of International Marketing. Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO)

**DX-311 Communication Skills****2 (1+1)**

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

**Practical:** Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations.

**DX-221 Dairy Extension Education****2 (1+1)**

History, need definition, philosophy, principles, approaches and objectives of extension education, Present status of extension and rural Development programmes. Teaching/learning process, Extension Teaching Methods, classification and selection of teaching methods. Nature and importance of communication. Key elements of communication. Models of communication, process, feedback and problems in communication. Importance of audio-visual aids in extension education. Classification, planning and selection of A.V. Aids. Identification of rural leaders, their characteristics, roles and functions in rural development, training of rural leaders. Definition of groups, natural types, principles of working with groups and their mobilization. Need, principles and steps of programme planning. Evaluation of extension programmes. Diffusion of innovations and categories of farmers. Conceptual orientation about different terms, like- PRA, RRA, IVLP/TAR, ATMA, ATIC, PTD etc.

**Practical:** Acquiring skill in use of audio-visual & other aids: Overheads Projector, Slide Projector, Use of VCR and PA system, Camera handling. Preparation and use of visual aids and printed material; Poster and chart, Flash card and flannel Graph, Circular letter, leaflet, pamphlet, folder. Group Discussion Technique, Developing Communication and Overall Skills, Brain-storming Technique for developing the Decision making Process, Interview-technique(s), Identification of problems of village farmers through interview method, Writing a radio script.

**7. COMPUTER SCIENCE****CS-111 Computer and Application Software Packages****3 (2 + 1)**

History, features, classification and organization and I/O peripheral devices for computers; Features of modern operating systems; number systems and coding schemes; Basics of networking and communications; Internet, e-mail concepts and application, Word-processing and desktop publishing, Electronic spreadsheet basics and operations, Database management system basics and operations; Fundamental of presentation-graphic packages. Recent strides in computing.

**Practical :** Windows Operating System, Word Processing software operations, Presentation Graphics software operations, Internet Surfing/Email usage, RDBMS software package basic operations, Spreadsheet software package basic operations.

**CS-312 IT in Dairy Industry****3 (2+ 1)**

Importance of Computerization and IT in Dairy Industries; Computers, Operating Environments and Information Systems for various types of Dairy Industries; Principles of communication; Automation, Inventory Control, Expert Systems and Artificial Intelligence; Concepts of System Analysis and Designing, SDLC, MIS, Decision Support Systems, Development of case studies; Databases: Characteristics of Databases, Different Approaches to Database Management, Database Normalization

**Practical:** Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food; Chemical kinetics in dairy processing; Use of word processing software for creating reports and presentation; Solving Elementary Optimization problems using suitable software package; Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit & Vegetable processing unit; Familiarization with software related to dairy industry; MIS report generation programs using RDBMS; Visit to Industry and knowledge of computer application in the same

**8. INTERDISCIPLINARY COURSES****EN-111 Environmental Studies****3 (3+0)****Unit 1: The Multidisciplinary nature of environmental studies**

Definition, scope and importance, Need for public awareness (2 lectures)

**Unit 2: Natural Resources:** Renewable and non-renewable resources: Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture fertilizer-pesticide problems, water logging, salinity, case studies, Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies, Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.(8 lectures)

**Unit 3: Ecosystems :** Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem:- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (6 lectures)

**Unit 4: Biodiversity and its conservation:** Introduction – Definition : genetic. Species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ conservation of biodiversity. (8 lectures)

**Unit 5: Social Issues and the Environment;** From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case studies, Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness (7 lectures)

**Unit 6: Human Population and the Environment:** Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV / AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies (6 lectures)

**Unit 7: Field work:** Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban / Rural / Industrial / Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours)

**MP-111 Milk Production Management & Dairy Development****3 (2+1)**

Introduction to Animal Husbandry. Distinguishing characteristics of Indian and exotic breeds of dairy animals and their performance. Systems of breeding and methods of selection of dairy animals. General dairy farm practices- identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes. Methods of milking, milking procedure and practices for quality milk production. Dairy farm records and their maintenance. Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises. Common disease problems in dairy animals, their prevention and control. Feed nutrients required by animal body. Feed resources

for milk production and their nutritive values. Digestive system of ruminants. Measures of feed energy. Nutrients requirements for growth and milk production. Feeding standards. Structure and function of mammary system. Milk secretion and milk let-down. Male and female reproductive system. Estrus to reproductive cycle. Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. Artificial insemination and embryo transfer and their role in animal improvement. Introduction to biotechniques in dairy animal production. Socio-economic and geographical features of Indian dairying. Traditional Systems of cattle keeping, estimates of milk production, utilization and sale; cattle & buffalo population and its distribution; trends in population growth, annual milk production and per capita availability; productivity profile of indigenous dairy stock, industrial by-products of livestock industry. Five year plans and dairy development; resource inadequacy, post partition pressure; catalytic action of international aid; major aided dairy projects; public sector milk supply schemes; co-operative dairy organizations, Anand pattern and perspectives; milk products manufacture in private sector, import substitutions in dairy products. Strategy of cattle improvement; pioneering role military dairy farm; key village scheme and its limitations, intensive cattle development programme concept, approach and achievements. Public sector dairy schemes, Economic burden performance analysis, National Dairy Development Board-aim and objectives, policy orientation in dairy development. Operation Flood-I,II,III : programmes & Outlay, implementation, success, achievements, integrated infrastructure of milk production, improvements of dairy co-operative organization, Dairy development Corporations, Co-operative Dairy Federations, Self-reliance in dairy development, income & employment potential. Conversion of milk into products, utilization pattern indigenous & western products. Dairy problems and policies.

**Practical :** Handling and restraining of dairy animals. External body parts and judging of cows and buffaloes. Feeding and management practices of calves. Identification of common feeds and fodders. Preparation of rations for adult animals. Milking of dairy animals and cleaning and sanitation of milking equipments. Identification of reproductive and digestive organs. Demonstration of semen collection, processing and artificial insemination.