

## DETAILED SYLLABUS (DAIRY ENGINEERING COURSES)

### 1. Workshop Practice 2(1+1)

#### Theory

Introduction: workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry. Heat treatment process: Hardening, tempering, annealing and normalizing etc. Metal work: Metal cutting. Soldering, Brazing. Welding: Electric arc and Gas welding. Smithy and forging operations: tools and equipments. Bench work: The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing. Introduction to following tool machines: (a) Lathe Machine (b) Milling Machine (c) Shaper and Planner (d) Drilling and Boring machines (e) Grinder (f) CNC Machines etc.

#### Practical

To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools ( lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

### 2. Fluid Mechanics 3(2+1)

#### Theory

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 gauges, Piezometer. Fluidflow: 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. Pump selection and sizing.

#### Practical

Study of various types of pipes and pipe fittings. Study of different types of valves. Study of reciprocating pump. Study of rotary gear pump. Study of piezometer. Study of U tube

Manometer. Study of inclined tube Manometer. Study of Venturimeter. Determination of frictional coefficient of given pipe. Determination of minor head loss. Study of Pitot tube. Study the construction and working principle of centrifugal pump. Study of Reciprocating pump. Study and measurement of flow of liquid by V- notch.

### 3. Engineering Drawing 1(0+1)

#### Practical

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 fit. 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

### 4. Thermodynamics 2(1+1)

#### Theory

Importance and applications of thermodynamics in Dairy/Food processing. Basic concepts: Thermodynamic systems, properties, state, 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. Analysis of non-flow and flow processes. The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability. Air Cycles: Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. I.C. Engines: Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines.

#### Practical

A visit to dairy/ food processing plant showing the thermodynamics applications/ devices. Study of 2-stroke and 4-strokes IC engines working. Study of S.I. and C.I. engines working Study of modern fuel injection systems of I.C. engines. Study of diesel fuel supply system (pump and fuel injector) of I.C. engine. Study of fuel supply system of a petrol engine. Study of cooling system of an I.C. engine (air cooling and water cooling). Study of lubrication system of I.C. engine. Study of Solar water heater and biogas plants and appliances

### 5. Heat & Mass Transfer 3(2+1)

#### Theory

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. Steady-state heatconduction 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. Mass transfer: Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal 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 Heat transfer in tubular heat exchanger: co current/ counter flow Heat transfer through composite wall. Heat transfer through legged pipes. Heat transfer through natural and forced convection

## **6. Boilers and Steam Generation 2(1+1)**

### **Theory**

Fuels: Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. Renewable energy sources: Concepts, classification, Types and description of renewable energy sources. Properties of steam: Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption. Steam generators: Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis. Air Compressors: Definition,

classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

### **Practical**

To study different types of boilers with the help of Lab models. To study Boiler mountings and steam-line layout and steam traps. Industrial exposure visit to plant with steam utilization. Study of Fire tube low pressure boiler installed in a dairy processing plant. Study of water softening plant installed with boiler in a dairy processing plant. Study the construction and working of Cochran boiler. Study of Babcock & Wilcox boiler. Study of different Boiler accessories.

## **7. Basic Electrical Engineering 3(2+1)**

### **Theory**

Alternating current fundamentals: Generation of alternating current or voltage, magnitude of induced E.M.F. Alternating current, R.M.S value and average value of an alternating current. Phase relation and vector representation. Cycle, Time period, Frequency, Amplitude, Phase and Phase Difference, Root – Mean Square Value, Average value, Form Factor, Crest or Amplitude Factor. Poly-phase Circuit: - Generation of Poly-phase Voltage, Phase Sequence, Interconnection of Three Phases such as Star Connection and Delta Connection and their respective value of current and voltages, Energy Measurement by using Single and Two Watt-meters. Transformers: - Working Principle of Transformer, Construction features of Core and Shell type transformer, Elementary theory of an Ideal Transformer, E.M.F. Equation of a Transformer, Vector diagram of transformer with and without load, Transformer losses, voltage regulation and efficiency of transformer, Construction and working on an Single Auto-transformer, Different parts of a 11/0.4 KV, Distribution Transformer. Three Phase Induction Motor: - Fundamental working principles, Production of rotating magnetic fields, construction, Different types of Rotor such as Squirrel Cage and Phase wound rotors, Starting of induction motors using Direct on Line (DOL) and Star-Delta Starter. Soft starter and variable frequency drives. Single Phase Induction Motors: - Introduction, Different types of single phase induction motors such as Split Phase, Capacitor type, Shaded Pole type, Universal or AC series motors, Repulsion start induction run motor, Repulsion – induction motor. DC Machine: - Construction and operation of DC generator, types of generators and their various characteristics. DC motors: Torque speed characteristics of DC motors, Starting and speed control of DC motors by using 3-point DC Starter. Alternators:- Elementary working principles, Different parts of an Alternators, Relation between Speed and Frequency, E.M.F. equation in an Alternators. Different types of Circuit Breaker and its use. Introduction to DG set system. Electric Power Economics: - Economics of Generation of electrical energy and related important terms such as, load curve, connected load, Maximum Demand, Demand Factor, Average load or demand, Load Factor, Diversity factor and its significance, Capacity Factor or Plant factor, Utilization Factor, Plant Operating Factor and Selection of Units and related numerical, Various types of Tariff used for calculation of electricity bill. Lighting system: Introduction to industrial lighting system. Energy Management and Power Factor Corrections: - Types of energy, Energy Management, Concept of Energy Audit. Concept of Power Factor, Disadvantages of low power factor, Causes of low power

factor, Various methods of improving low power factor, Location of power factor correction equipment, Advantages of power factor improvement.

### **Practical**

Introduction to various basic circuits of parallel wiring, stair case wiring, fluorescent light fitting. Study of voltage and current relationship in case of Star connected load. Study of voltage and current relationship in case of Delta connected load. Measurement of power in 3-phase circuit; for a balanced load, using watt meters. Measurement of power in 3-phase circuit; for a unbalanced load, using watt meters. Measurement of iron losses of Single Phase transformer by conducting open circuit test. Measurement of Copper losses of Single Phase transformer by conducting short circuit test. Starting and reversing the speed of a single phase induction motor. Starting and reversing the speed of a three phase induction motor using Direct on Line (DOL) Starter. Starting and reversing the speed of a three phase induction motor using manual Star Delta Starter. Starting and reversing the speed of a DC shunt motor using 3-point DC Starter. Starting of slip-ring induction motor by manual and automatic Slip-ring Induction Motor Starter. To determine the relation between induced armature voltage and speed of separately /self excited DC Shunt Generator.

## **8. Refrigeration and Air-Conditioning 3(2+1)**

### **Theory**

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-S and p-h diagrams; Mathematical analysis of vapour compression refrigeration system. Refrigerants: Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, HFC, HCFC etc); Brine, their properties and comparison. Multi-Pressure Refrigeration Systems: Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems. Refrigeration Equipments and Controls: Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation. Design and Balancing of Refrigeration System: Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis. Cryogenic Freezing: Cryogenics, cryogens, properties, applications, cryogenic freezers. Psychrometry: Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls. Air-conditioning Systems: Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. Cold Storage: Types of cold

storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

### **Practical**

Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools. Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler. Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler. Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant. Estimation of installed cooling capacity with the help of observed working pressures. Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT). Study of specifications, components, operation, control and maintenance of a Cold Storage. Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc. Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications. Study of different types of capacity control devices used with compressors in a refrigeration plant. Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up. (comparison of actual and theoretical performance). Experimental study of an year-round air-conditioning system on an air-conditioning tutor or an experimental set-up. Determination of SHF and Bypass factor etc. Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor. Measurement of psychrometric properties using psychrometric meters/gadgets Industrial exposure visit to refrigeration/air-conditioning plant.

## **9. Dairy Engineering 3(2+1)**

### **Theory**

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, cold and hot separators, Bactofuge, in-line standardization system, 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. Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling 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**

Study of S. S. pipes, fitting and gaskets. Study and selection of pump. Study of different types of milk filter. Study of equipments at raw milk reception dock. Constructional details, operation and maintenance of straight through can washer. Constructional details, operation and maintenance of C.I.P. system. Constructional details, operation and maintenance of homogenizers. Constructional details, operation and maintenance of batch pasteurizer. Constructional details, operation and maintenance of HTST pasteurizer. Comparison of conventional and modern pasteurizer. Constructional details, operation and maintenance of cream separators. Constructional details, operation and maintenance of sterilization systems. Constructional details, operation and maintenance of pouch filling machine. Constructional details, operation and maintenance of different types of agitators. Constructional details, operation and maintenance of bottle filling and capping machine. Visit to a dairy processing plant.

## **10. Dairy Process Engineering 3(2+1)**

### **Theory**

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 powder, 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. Processing equipments: Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. Packaging 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**

Constructional details, operation and maintenance of Vacuum pan. Constructional details, operation and maintenance of multiple effect evaporator. Constructional details, operation and maintenance of spray drier. Constructional details, operation and maintenance of butter making equipment. Constructional details, operation and maintenance of equipment related to ghee production. Constructional details, operation and maintenance of ice-cream making equipment. Constructional details, operation and maintenance of cheese making equipment. Constructional details, operation and maintenance of reverse osmosis and ultra filtration system. Design problems on double effect evaporator and vacuum pan. Visit to a milk product plant

## **11. Instrumentation and Process Control 3(2+1)**

### **Theory**

Instrumentation scheme & characteristics: Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Definition, Application and types of measurements, instrument classification, Functional elements of an instrument, standards, calibration, introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems. Introduction to various types of sensors: Definition, principle of sensing & transduction, classification, selection and applications of Sensors., Measurement of parameter : Measurement of length ,angle, area , temperature , pressure flow , speed, force , torque, vibration , level , concentration (conductivity and ph) measurement . Flow measurement using magnetic flow measurement. Piezoelectric transducer. Micro-sensors and smart sensors: Construction, characteristics and applications. Electronic Instruments: Role and importance of general purpose test instruments, Electronic Millimeter, Cathode Ray Oscilloscope, Measurement of amplitude, frequency and phase using CRO Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Display devices and recorders like X-Y & X-T recorders. Automation: Introduction to plant automation, automation hierarchy, PLC, SCADA

### **Practical**

Strain gauge characteristics and weight measurement. Measurement of pressure using bellows and diaphragm. Preparation and calibration of thermocouple. Study the construction and working of Bourden pressure gauge. Test and calibration of pressure gauges using dead weight tester. Study the mechanism of pH meter and its electrodes. Study a Proximity sensor. Study the different parts and working of pressure switch. Study the different parts of an indicating instrument. Study of RTD and Thermister. Study of different speed measurement sensor/ instruments. Study of LVDT. Study of level/flow controller. Study of PLC. Visit to a automatic controlled dairy plant.

## **12. Food Engineering 3(2+1)**



## **Theory**

Rheology: 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, Design of food freezing equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods. Freeze concentration. 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, Classification of driers, tray, vacuum, vacuum band, tunnel, bin, solar, drying, freeze drying, spin flash. Freeze dehydration: Heat and mass transfer, Calculation of drying time, Industrial freeze drying. Other food processing operations and equipments: Equipment for pulping, fruit juice extraction, blanching, dehulling, size reduction, milling, extrusion and distillation.

## **Practical**

To determine physical properties of food product. To determine viscosity of food product. To study food freezers. To study freeze drier. To determine drying characteristics of food product. To compare various drying methods. To determine juice yield. To compare hot water and steam blanching. To study construction and working of distillation system. To study various size reduction equipments. Visit to cold storage. Visit to food processing plant.

## **13. Material Strength & Dairy Machine Design 3(2+1)**

### **Theory**

Strength of Materials: 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. Dairy 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**

Design problems on applications of engineering statics and dynamics. Design problems on applications of work and energy. Design problems on applications of linear and angular momentum. Design problems on stress-strain diagram evaluation of elastic constants. Study on shear force and bending moment diagrams and its applications. Design problems on applications of flexural stresses. Design problems on applications of

shearing stresses in beams. Study on system of limits, fits and tolerances and their applications. Design stresses in elementary machine parts. Design features and applications of shafts. Design features and applications of axles. Design features and applications of keys. Design features and applications of couplings. Design problems on various types of power transmission systems. Design features and applications of bearings. Design features and applications of springs. Design problems on agitator/stirrer. Design features of milk silo.

## 14. Dairy Plant Design And Layout 2(1+1)

### Theory

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. Hygienic design considerations for dairy processing plants. Planning: 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. Dairy plant design aspects: 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. Building construction materials: Floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows. Other design aspects: Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. Computer aided Design: Introduction to CAD software.

### Practical

Building symbols and convention. Symbols for equipments. Study of process schedule. To draw layout of collection/chilling centre. Visit to dairy processing plant for understanding of layout of different sections. To draw layout of small dairy plant. To draw layout of small dairy plant using CAD. To draw layout of medium dairy plant. To draw layout of large dairy plant. To draw layout of cheese plant. To draw layout of ice-cream plant. To draw layout of butter manufacturing unit. To draw layout of ghee plant. To draw layout of composite dairy plant

## 15. Energy Conservation and Management 2(1+1)

### Theory

Introduction: Potential and opportunities of industrial energy conservation in dairy and food processing. Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE). Electricity Act 2003, Integrated energy policy. Energy management & audit: Definition, energy audit, need, types of energy audit. Energy

audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy balances and computation of efficiencies of equipment. Role of Energy inspectors and Auditors in energy management. Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques. Quality of power, Power factor and its improvement. Transformers, losses in transformers. Energy savings in transformers. Electric motor-selection and application, Energy efficient motors. Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy. Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters. Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls. Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities. Energy conservation in steam distribution systems, efficient piping layouts, protective & insulation coverings in utility pipes. Steamconservation opportunities. Upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors. Maintenance and upkeep of Vacuum lines and Compressed air pipe lines. Conservation and reuse of water, water auditing. Energy conservation opportunities in Wastewater treatment. Processing equipments: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying & Freezing. Role of steam traps in energy saving. Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator. Energy conservation in buildings: Concepts of "Green Buildings". Waste-heat recovery and thermal energy storage in food processing facilities. Condensate recovery and reuse. Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc. Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects. Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries. Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

### **Practicals**

Study of Energy Conservation Act 2001. Study of schemes of BEE. Study of concepts of Energy Balance in Unit Operations and System boundaries. Solving examples on energy balances. Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve. Determination of Load factor of an installation. Study of use of power factor meter and determination of true power and wattles power using pf meters, Watt meter, Ammeter and Volt meter. Study of performances of a general type of induction motor and an energy efficient induction motor. Study of use of VSD. Study of various types of electrical appliances classified under different BEE Star Ratings. Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency. Exercise on energy audit of Students Experimental Dairy Plant (SEDP-DSc College, Hebbal).