3.1 FLUID FLOW

L	T	P
4	-	3

RATIONALE

This subject aims at the basic concepts of fluid flow, measurement techniques involved for the same and equipments used for the transportation of fluids. With this background, students will be able to quantitatively find out material and power requirement for a process.

DETAILED CONTENTS

1. Various types of flow – steady and unsteady, uniform and non-uniform flow, streamline flow, laminar and turbulent flow, rotational and irrotational flow. (7 hrs)

   - Types of fluid: compressible and incompressible fluid, Newtonian and non-Newtonian fluid, properties of fluids.

2. Fluid statics and dynamics, Pascal's law, hydrostatic law, various types of manometers : U tube manometer and differential manometer. (17 hrs)

   - Continuity equation, Bernoullis theorem, flow through pipes and open channels: Hagen poiseulli's equation, friction factor charts, friction losses in pipes, friction loss from sudden enlargement and contraction, effect of roughness in pipes.

   - Simple numerical problems related to the above topics.

3. Flow measurement: flow through venturimeter, orifice meter, flow nozzle, pitot tube, rotameter. (10 hrs)

4. Flow through Fluid Machinery. (30 hrs)

   - Classification of pumps, construction and working of reciprocating pump, centrifugal pump and rotary pump, priming and NPSH, cavitation, power requirement, efficiency of centrifugal pump, specific speed. Blowers and compressors.

   - Pipe and Fittings: Different types of pipes, schedule Number, ID and OD of pipe, colour coding of industrial piping used for transportation of various fluids, different types of valves and fittings: Globe valve, Butterfly valve, Gate valve, Ball valve and Needle valve.

   - Dimensional analysis: Rayleigh's method, Buckingham Pi method, dimensionless numbers and their significance.

LIST OF PRACTICALS

1. Verification of Bernoullis equation
2. Determination of friction loss in flow through pipe
3. Calibration of orifice meter and calculation of Cd, Cv, Cc
4. Calibration of Venturi meter
5. Calibration of Rotameter
6. Determination of discharge coefficient of V-notch
7. Study of constructional feature of centrifugal, gear, reciprocator diaphragm pump, blower and compressors and assembling and disassembling
8. Study of characteristics, curves of centrifugal, reciprocating pump
9. Study of fluidized bed characteristics
10. Calculation of Reynolds number

INSTRUCTIONAL STRATEGY

The students should be imparted theoretical as well as practical knowledge about all the topics supplementing with electronic media.

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by McCabe W.L. & Smith J.C. McGraw Hill.

2. Chemical Engineering Hand Book by Perry K. Chilton.

3. Chemical Engineering Vol.I and II by Coulson and Richardson. Pergamota Press Publications.

4. Introduction to Chemical Engineering by Bedger and Banchero, McGraw Hill Publication.

5. Principles of Unit Operations by Alen Foust, John Willey Publicaiton.

6. Chemical Engineering Fluid Mechanics by K.A. Gavahane, Nirali Publications.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1.	7	10
2.	17	30
3.	10	15
4.	30	45
Total	**64**	**100**

3.2 MECHANICAL OPERATIONS

L	T	P
3	-	3

RATIONALE

This subject will impart knowledge to the students on working of individual mechanical operations and their significance in chemical industries. With this information student can control the operation of equipment and regulate production.

DETAILED CONTENTS

1. Characterization of Solid Particles (8 hrs)

   Particle shape, particle size, mixed particle sizes and size analysis, expressions for specific surface of mixture, average particle size, number of particles in mixture (no derivation).

2. Size Reduction (14 hrs)

   i) Energy and power requirements in crushing, crushing efficiency, mechanical efficiency, expression for power required by machines.

   ii) Crushing laws: Rittinger's law, Bond's law and Kick's law

   iii) Size reduction equipment: classification and names; study of machines: Blake crusher, Jaw crusher, Dodge crusher, Grinding rolls, Roll crusher Impactor, Attrition mill, Ball mill, Fluid energy mill, Colloid mill, Rotary knife cutter, Flow sheet for closed circuit grinding

3. Mechanical Separation (26 hrs)

   i) Screen analysis, Tyler standard screen series, material balances over screen capacity and screen effectiveness, definition and final expression only.

   ii) Screening equipment: Gyrating screens, Stationary screens and Grizzlies vibrating screens

   iii) Filteration: (Qualitative treatment only) classification of filteration, filter media, filter aids, mechanisms of filteration, discontinuous pressure filters, Filter press, Shell and leaf filters; Continuous: Vacuum filters, Rotary drum filters, Centrifugal filters; Suspended batch centrifuges; Clarifying filters.

   iv) Separation based on the motion of particles through fluids; Gravity classifiers, Sorting classifier; Thickeners: Batch sedimentation, rate of

sedimentation; centrifugal settling process: Cyclone, Hydro-cyclone, Tabular centrifuge, Disk centrifuge, Nozzle discharge centrifuge

v) Mixing of solids and pastes, Change can mixer, Double motion paste mixers, Two arm Kneader, Kneader and disperser blades

LIST OF PRACTICALS

1. To find the sieve analysis of a given sample of solid particles by sieve shaker
2. To determine the grindability of solids by ball-mill
3. To determine the crushing efficiency by a roll crusher using a sample of solid particles
4. To find the rate of filtration with the help of filter press
5. To perform an experiment on rotary vacuum filter and find rate of filtration
6. To perform an experiment on a cyclone separator and find collection efficiency
7. To perform an experiment on mixers for liquid-liquid mixing and find rate of mixing
8. To perform an experiment on mixer for solid-liquid mixing and find rate of mixing
9. To perform and experiment on separation of solid particles using a sedimentation tank

INSTRUCTIONAL STRATEGY

Adequate competency needs to be developed by giving sufficient practical knowledge to mechanical operation (characterization of solid particles, size reduction, energy requirement and mechanical separation). A field visit may be conducted to expose the working of various conveyers and filtration equipment in industries.

RECOMMENDED BOOKS

1. Chemical Engineering, Vol. I and II by Coulson and Richardson, Pergamon Press Publication
2. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication

3. Introduction to Chemical Technology by Badger and Banchero, McGraw Hill Publication
4. Fluid Mechanics and Its Applications by Gupta and Gupta, Wiley Eastern Publication
5. Principles of Unit Operations by Alen Foust, John Wiley Publication
6. Unit Operations-I, by KA Gavahane, Nirali Publication
7. Unit Operations by Chattoupadhay.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1.	8	20
2.	14	30
3.	26	50
Total	**48**	**100**

3.3 CHEMICAL PROCESS CALCULATIONS

L	T	P
4	-	-

RATIONALE

This subject provides the knowledge of material and energy requirements for a process and with this knowledge raw material requirement for a given process can be calculated.

DETAILED CONTENTS

1. Definition of Chemical Engineering with brief history, future and career opportunities for chemical engineers. (4 hrs)

2. Difference between Unit Operations and Unit Processes. (6 hrs)

3. Units and dimensions, inter conversion of units of pressure, volume, force, work, energy, viscosity, temperature, specific gravity and heat in S1, CGS, MKS and simple numerical problems. (10 hrs)

4. Boyle's law, Charle's Law, Ideal gas equation, Dalton's law, Amagat's law, Relation between Vol% = Mole% = Press%, Average molecular weight of gas mixture, Density of gas mixture and simple numerical problems. (6 hrs)

5. Concept of mole, gm moles, gm atoms, mole fraction and concentration of solution in different ways like molarity, molality and normality, mass%, mass fraction, volume%, volume fraction. (6 hrs)

6. Definition and meaning of material balance, basic steps to be followed in the material balance calculation, numerical problem based on material balance without chemical reaction; unit operations like distillation, drying, evaporation, meaning of by bass, recycle and purge system of material balance. (12 hrs)

7. Definition and meaning of energy balance, standard heat of reaction, and formation, sensible heat, latent heat, heat capacity at constant pressure, relation between Cp and Cv, standard heat of reaction: heat of formation and heat of combustion, Hess's law of constant heat summation. (10 hrs)

8. Definition of combustion, heat of combustion, air requirement (theoretical air, excess air and theoretical oxygen requirement). (10 hrs)

INSTRUCTIONAL STRATEGY

Emphasis should be laid on problem solving in all the area of material and energy balance. Simple practicals relating to wet bulb temperature, dry bulb temperature and humidification chart should be done. Students should be encouraged to make flow sheets for various processes. This will help the students to understand the subject better and solve intricate problems in various areas.

RECOMMENDED BOOKS

1. Solved Example in Chemical Engineering by G.K. Roy, Khanna publication.

2. Chemical Process Principles by Hougen and Watson, Wiley International Edition.

3. Stoichiometry by Bhatt and Vohra,Tata McGraw Hill Publicaiton.

4. Basic Principles and Calculations in Chemical Engineering Himmelblaw, Prentice Hall Publication.

5. Stoichiometry by K.A. Gavhane, Nirali Publishers

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1.	4	5
2.	6	10
3.	10	15
4.	6	10
5	6	10
6	12	20
7	10	15
8	10	15
Total	**64**	**100**

3.4 INTRODUCTION TO ENGINEERING MATERIALS

L	T	P
4	-	-

RATIONALE

The knowledge of engineering materials is essential for Chemical Engineering discipline. The knowledge of mechanical , electrical, thermal and chemical properties of a material is necessary to make a proper selection of the material for process equipment. Effect of surrounding materials, failure under service conditions etc also affect the material selection

DETAILED CONTENTS

1. Importance of engineering materials (5 hrs)

2. Classification of engineering materials and their use in chemical industries (8 hrs)

3. Classification of engineering materials (30 hrs)

   3.1 Metallic Materials

      3.1.1 Ferrous Metals
      Important varieties of iron ores, cast iron; types, properties and uses of cast iron, pig iron: types of pig iron. Wrought iron: properties and uses of wrought iron; Steel: factors affecting physical properties of steel and uses of steel (no manufacturing process)

      3.1.2 Non-ferrous Metals
      Aluminium, copper, lead, nickel, tin and zinc, their properties and uses

      3.1.3 Various alloys of aluminium, copper, nickel and steel

      3.1.4 Study of phase diag. of Fe-C

      3.1.5 Classification of stainless steels, properties and uses.

   3.2 Non-metallic materials

      3.2.1 Polymers
      Nylon – 66, nylon – 6, polyesters, polycarbonates, polyurathanes, LDPE, HDPE PVC, Polypropylene, rubber

3.2.2 Ceramics
Definition of ceramic, clays, properties of clay, earthen wares and stone wares, uses of stonewares

3.2.3 Glass
Definition, classification, composition, types and properties of glass

4. Mechanical, thermal and electrical properties (15 hrs)

Tensile strength, compressive strength, shear strength, ductility and malleability, methods of improving strength; specific heat, glass transition temperature, crystalline melting temperature; thermal conductivity, dielectric strength, dielectric constant, power loss and electrical diffusivity

5. Specification of materials according to BIS (6 hrs)

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students with the help of practical examples. Each topic should be supplemented with assignments. Extension lectures by experts from glass and other industries can enrich the students with better inputs regarding various types of techniques and latest developments in industry

RECOMMENDED BOOKS

1. Materials in Industry by WJ Patton; Prentice Hall Publication

2. Introduction to Engineering Materials by Aggarwal; Tata McGraw Hill Publication

3. Material Science by Narula; Tata McGraw Hill Publication

4. Elements of Mettalurgy by HS Bawa; Tata McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	5	5
2	8	15
3	30	45
4	15	25
5	6	10
Total	**64**	**100**

3.5 HEAT TRANSFER - I

L	T	P
4	-	3

RATIONALE

Most of the Chemical Engineering operations will involve either heat addition or heat removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat transfer mechanisms such as conduction, convection and radiation. These methods can then be used for understanding the performances of heat transfer equipment used in almost all chemical and related industries

DETAILED CONTENTS

1. Modes of Heat Transfer (4 hrs)

   Conduction, Convection, Radiation, concept of steady state and unsteady state heat transfer

2. Conduction (20 hrs)

   Fourier's law of heat conduction, thermal conductivity of materials – solids, liquids and gases and effect of temperature on thermal conductivity, one dimensional steady state heat conduction through a composite wall, steady state heat conduction through a variable area – the plain wall, the cylinder and the sphere.

   Insulation and insulating materials, critical thickness of insulation, physical properties of insulating materials

3. Convection (25 hrs)

   Convective heat transfer and concept of heat transfer coefficient, free and forced convection, dimensional analysis and significance of various dimensional groups such as Reynolds number, Prandtl number, Nusselt number., Grasshof number., Stanton number. Peclet number, empirical correlations for free and forced convection, brief introduction about boiling, condensation and evaporation

4. Radiation (15 hrs)

   Black body radiation, Planck's law, Wein's displacement law, Stefan – Boltzmann Law, Kirchhoff's law, Grey body, view factor, radiative heat exchange between black bodies, radiation shield, absorption and emission in a gaseous medium

LIST OF PRACTICALS

1. To find the thermal conductivity of (material at different temperature) Metal Rod.
2. To calculate the rate of heat loss through composite wall.
3. To determine experimentally the k value of insulating powder.
4. To calculate the heat transfer co-efficient for natural convection.
5. To calculate the heat transfer co-efficient for forced convection.
6. To determine overall heat transfer co-efficient for an open pan evoporator.
7. To study dropwise and filmwise condensation.
8. To study Stefan boltzman law.
9. To calculate emissivity of a material.

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practicals should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer.

RECOMMENDED BOOKS

1. Heat Transfer by Chapman, MacMillan Publication.
2. Principles of Heat Transfer by Kreith, Harper and Row Publication.
3. Process Heat Transfer by Kern, McGraw Hill Publication.
4. Heat Transfer by McAdams, McGraw Hill Publication.
5. Heat and Mass Transfer by DS Kumar.
6. Heat Transfer by KA Gavahane, Nirali Publicaitons.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Alloted (%)
1	4	10
2	20	30
3	25	35
4	15	25
Total	**64**	**100**

3.6 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P
3	-	2

RATIONALE

The objective of this subject is to impart fundamental knowledge and skills regarding basic electrical and electronics engineering, which diploma holders will come across in their professional life. This course will provide the students to understand the basic concepts and principles of d.c. and a.c. fundamentals, electromagnetic induction, transformers, motors distribution system, domestic installation, electrical safety etc. The students will also learn basic electronics including diodes and transistors and their applications.

DETAILED CONTENTS

1. Application and Advantage of Electricity (04 hrs)

   Difference between ac and dc, various applications of electricity, advantages of electrical energy over other types of energy

2. Basic Electrical Quantities (04 hrs)

   Definition of voltage, current, power and energy with their units, name of instruments used for measuring above quantities

3. Electromagnetic Induction (04 hrs)

   Production of e.m.f., idea of a transformer and its working principle

4. Transmission and Distribution System (08 hrs)

   Key diagram of 3 phase transmission and distribution system, Brief functions of accessories of transmission line. Difference between high and low voltage distribution system, identification of three-phase wires, neutral wire and earth wire in a low voltage distribution system. Identification of voltages between phases and between one phase and neutral. Difference between three-phase and single-phase supply. Arrangement of supply system from pole to the distribution board, function of service line, energy meter, main switch, distribution board

5. Domestic Installation (08 hrs)

   Various types of domestic circuits, various accessories and parts of domestic electrical installation. Identification of wiring systems, staircase installation

6. Electric Motors and Pumps (10 hrs)

Definition and various applications of single-phase and three-phase motors. Connection and starting of three-phase induction motors by star-delta starter. Conversion of horse power in watts or kilowatts, Type of pumps and their applications, difference between direct online starter and star delta starter, characteristics and applications of servo motors.

7. Electrical Safety (04hrs)

Electrical shock and precautions against shock, treatment of electric shock, concept of fuses and their classification, selection and application, concept of earthing and various types of earthing, applications of MCBs and ELCBs

8. Basic Electronics (06hrs)

Basic idea of semiconductors – P and N type; diodes, zener diodes and their applications, transistor – PNP and NPN, symbols, identification of terminals of transistor, current flowing in a transistor, its characteristics and uses. Characteristics and applications of a thyristor

LIST OF PRACTICALS

1. Connection of a three-phase motor and starter with fuses and reversing of direction of rotation
2. Connection of a single-phase induction motor with supply and reversing of its direction of rotation
3. To test a battery for its charged and discharged condition.
4. Identify the different faults in a domestic wiring system
5. Connection and reading of an electric energy meter with supply and load using ammeter, voltmeter, wattmeter
6. Study of a distribution board for domestic installation
7. Ohm’s law verification
8. Verification of law of resistance in series
9. Verification of law of resistance in parallel
10. Draw V-I characteristics of P-N junction diode
11. Draw input and output characters of a transistor
12. Draw reverse break down characteristics of a zener diode

INSTRUCTIONAL STRATEGY

The teacher should give emphasis on understanding of concept and various terms used in the subject. Practical exercises will reinforce various concepts.

RECOMMENDED BOOKS

1. Basic Electrical Engineering by PS Dhogal; Tata McGraw Hill Publishers, New Delhi
2. A Text Book of Electrical Technology, Vol. I and II by BL Thareja; S Chand and Co., New Delhi
3. Basic Electricity by BR Sharma; Satya Prakashan, New Delhi
4. Basic Electrical Engineering by JB Gupta, S Kataria and Sons, Delhi
5. Experiments in Basic Electrical Engineering by SK Bhattacharya and KM Rastogi, New Age International Publishers Ltd., New Delhi
6. Basic Electronics by VK Mehta; S Chand and Co., New Delhi
7. Electrical Machines by SK Bhattacharya; Tata McGraw Hill, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	4	10
2	4	10
3	4	10
4	8	15
5	8	15
6	10	18
7	4	10
8	6	12
Total	**48**	**100**

4.1 MASS TRANSFER – I

L	T	P
4	-	3

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipments like distillation column, gas absorption columns, dryers, cooling towers and extraction columns etc which are used in industries for purification of products

DETAILED CONTENTS

1. Introduction to Mass Transfer Operations and Classification (05 hrs)

2. Diffusion (20 hrs)

   Definition of diffusion and its classification viz diffusion under concentration, pressure and thermal gradient, forced diffusion and eddy diffusion.

   Role of diffusion in mass transfer, fick's law, diffusion in the gas phase equimolecular counter diffusion, diffusion through stationary gas, Mass transfer coefficient, film theory and penetration theory of mass transfer, diffusion in solids, relation between film and overall mass transfer coefficient.

   Simple numerical problems based on Flick's law definition and physical meaning of mass transfer coefficient. Important correlations (no derivation), meaning of each term

3. Gas Absorption and Desorption (15 hrs)

   Condition of equilibrium between gas and liquid, mechanism of absorption, material balance and design equation, operating line. Concept of transfer unit (HTU and NTU) height of column based on condition-gas film, based on condition-liquid film, height of column based on overall coefficient. HETP for packed column of distillation, equipment used, types of tower packing, properties of tower packing, problems encountered like flooding, channeling, and weeping, loading, choice of solvent, Raoult's law and Henry's law.

4. Humidification and Dehumidification (12 hrs)

   Definition of humidity, saturated gas, relative humidity, percentage humidity, humid heat, humid volume, dew point, total enthalpy, phase equilibria – relation between equilibrium, mole fraction and saturation humidity, use of humidity chart.

Dry bulb and wet bulb temperature, meaning and principle only

Gas liquid contact operation: names of adiabatic and non-adiabatic equipment – natural draft cooling tower, humidifier and dehumidifier, different cooling tower arrangements, spray chambers, spray ponds.

5. Drying (12 hrs)

General Definition – moisture content (wet and dry basis), equilibrium moisture content, bound moisture content, unbound moisture content, free and critical moisture content, rate of drying curve, time of drying, drying equipment – tray dryer, rotary dryer, spray dryer, fluidized bed dryer and application.

LIST OF PRACTICALS

1. Diffusion coefficient measurement in liquids
2. Diffusion coefficient measurement in solids
3. Wetted wall column experiment
4. Experiment on packed bed absorption tower
5. To estimate various humidification terms using humidity chart from dry and wet bulb temperature
6. To study time of batch drying in tray dryer
7. Experiment on cooling tower.

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Treybal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
4. Mass Transfer by Sherwood Pigford and Wilke, McGraw Hill Publication
5. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
6. Mass Transfer Operations by Kiran D. Patil, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	10
2	20	30
3	15	20
4	12	20
5	12	20
Total	**64**	**100**

4.2 CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P
4	-	-

RATIONALE

It is a core subject of chemical engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal systems used in industry.

DETAILED CONTENTS

1. Introduction and Basic Concepts (16 hrs)

   Systems, processes, surroundings, homogeneous and heterogeneous systems, closed, open and isolated systems, intensive and extensive properties, state and path functions, concept of internal energy, enthalpy, entropy, free energy and equilibrium, equation of state, ideal gas law, Vanderwaal's equation, Amagat's law, Dalton's Law, Henry's law, Raoult's law, zeroth law of thermodynamics

2. First law of thermodynamics for open, closed and cyclic systems, Joules experiments. Calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible isometric, isothermal, isobaric, adiabatic and polytropic process (16 hrs)

3. Second law of thermodynamics, limitations of first law, general statement of second law of thermodynamics, heat engine, entropy change for reversible and irreversible process, calculations of entropy change and ideal gases adiabatic and isothermal mixing process, carnot cycle, heat engine and its efficiency, thermodynamics temperature scale. (16 hrs)

4. Third law of thermodynamics: third law of thermodynamics and its applications, application of the laws of thermodynamics: heat pumps, refrigerations, coefficient of performance, properties of reorients, vapour compression refrigeration cycle, absorption refrigeration cycle, commonly used refrigerants. (16 hrs)

INSTRUCTIONAL STRATEGY

Emphasis should be given to numerical aspect to give in-depth knowledge of the subject. This will make the subject interesting and improve student's involvement in the subject.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, Mc Graw Hill.

2. Chemical Engineering thermodynamics by K.V. Narayanan, Prentice Hall India.

3. Chemical Engineering Thermodynamics by Dodge, Mc Graw Hill.

4. Chemical Engineering Thermodynamics by YVC Rao

5. Engineering Thermodynamics by PK Nag

6. Thermal Engineering by Ballaney

7. Chemical Engineering Thermodynamics by K.A. Gavhane, Nirali Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	**64**	**100**

4.3 HEAT TRANSFER - II

L	T	P
4	-	3

RATIONALE

This subject enables the students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performances of various heat transfer equipment such as heat exchangers, condensers, boilers, evaporators etc used in almost all chemical and related industries

DETAILED CONTENTS

1. Condensation, Boiling and Evaporation (10 hrs)

   Concept of Condensation, Types of Condensation i.e. Dropwise condensation and filmwise condensation, Concept of boiling, oiling curve, heat transfer medium i.e. diphenyl, downthern, concept of evaporation, Boiling point elevation.

2. Heat Exchangers (20 hrs)

   LMTD; introduction, LMTD for co-current, counter current and cross flow, construction and desception of (i) double pipe (ii) shell and tube heat exchanger. (ii) Plate type heat exchanger. Simple numerical problems concerning single pass 1 – 1 exchanger, 1 – 2 parallel counter flow heat exchangers. Fouling factors, roughness of surfaces and their effect,individual and overall heat transfer coefficient, extended surface equipment and their efficiency

3. Condensers (8 hrs)

   Construction details and working of shell and tube condenser and contact condenser

4. Boilers (10 hrs)

   Coal and oil fired boilers, can chraine boiler, Babcoxs and wil coxs, wilan boiler simpler boiler, oil fired boiler (nestler), Lanka shire boiler

5. Evaporators (10 hrs)

   Evaporation Capacity, Evaporation Economy, types of evaporators; open pan, long tube vertical evaporator, falling films, forced circulation, feeding arrangement, concept of multiple effect evaporation.

6. Furnaces (6 hrs)

   Classification based on fuel used (oil fired, coal fired, gaseous fuel fired) working and construction details of cupola furnance, reverberatory furnace, muffle furnace.

LIST OF PRACTICALS

1. To determine the heat transfer coefficient with the help of double pipe heat exchanger using parallel flow

2. To determine the H.T coefficient with the help of double pipe heat exchanger using counter flow

3. To determine heat transfer coefficient in shell and tube heat exchanger using counter flow

4. To determine heat transfer coefficient in shell and tube heat exchanger using parallel flow

5. To determine the rate of evaporation in a jacketed bottle (open pan evaporation)

6. Experiment on a single effect evaporator and determination of steam economy

7. Experiment on cooling tower and to determine rate of cooling

8. To determine heat transfer rate in finned tube heat exchanger

9. To find the effect of concentration on boiling point of a solution (Duhring's rule)

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practicals should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer.

RECOMMENDED BOOKS

1. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York

2. Heat Transer 7^{th} Ed. By Holman JP; McGraw Hill, New York

3. Applied Process Design for Chemical and Petrochemical Plants, Volume III by Ludwig, E; Gulf Publishing Co., Houston, Texas

4. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.

5. Heat Tranfer by K.A. Gavhane, Niral Publicatins.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	15
2	20	30
3	8	15
4	10	15
5	10	15
6	6	10
Total	**64**	**100**

4.4 CHEMICAL TECHNOLOGY

L	T	P
4	-	3

RATIONALE

A chemical engineer, during his/her professional career is primarily working in industries manufacturing various chemical products. It is therefore necessary to provide information to chemical engineering student about the new materials, the chemical involved and manufacturing process of some important and frequently used chemical products.

DETAILED CONTENTS

1. Flow Sheets and Symbols (10 hrs)

- Types of flow sheets : block diagram process flow sheets, piping and instrumentations diagram, utility line diagram, equipment layout.
- Reactors, size reduction equipments, filters, driers, different types of columns, heat exchanger, pumps and compressors, material handling, storage vessels, mixers, screens separators.

2. Oil and Fats Industry (10 hrs)

- Method of extracting vegetable oils by mechanical and solvent extraction, flow sheet and process description.
- Soaps and Detergents: Distinction between soaps and detergents, different additives and their role in soaps and detergents. Continuous hydrolysis and saponification process. Flow sheet for continuous process for fatty acids, soap and glycerine. Manufacture of detergent.

3. Pulp and Paper Industry (12 hrs)

- Definition of pulp, raw materials used for making pulp, brief description of Mechanical pulping, Chemical pulping and Semi-chemical pulping. Comparison of Sulfate pulping and Sulfite pulping process. Process description of pulping and chemical recovery by sulfate (Kraft process) with flow sheet, major engineering problems.
- Definition of paper, types of paper products. General manufacturing steps for paper making using Fourdrinier machine.

4. Sugar and Fermentation Industry (12 hrs)

- Process description for manufacturing of sugar from sugar cane, major engineering problems. Brief description of sulfitation process and carbonation process.

- Manufacturing process of starch from Maize and Dextrin by starch hydrolysis method with flow sheet.
- Introduction of fermentation process. Manufacturing of ethanol by fermentation of molasses with flow sheet, major engineering problems. Manufacturing of Beer and wine (process only).

5. Fertilizer Industry (10 hrs)

- NPK Fertilizers
- Properties and uses, manufacturing process of Ammonia with flow sheet, major engineering problems.
- Properties and uses, manufacturing process of Urea with flow sheet, major engineering problems.
- Properties and uses, manufacturing process of Ammonium Nitrate with flow sheet, major engineering problems.
- Properties and uses, manufacturing process of single super phosphate triple super phosphate and with flow sheet, major engineering problems.
- Properties and uses, manufacturing process of Ammonium phosphate with flow sheet.

6. Cement Industry (5 hrs)

- Names of different types of cement, composition of Portland cement, raw materials.
- Dry process for manufacturing of Portland cement, major engineering problems.

7. Sulphur Industry (5 hrs)

Properties, uses and grades of sulfuric acid, methods of production, raw material, contact process for manufacturing of sulfuric acid with flow sheet, major engineering problems.

LIST OF PRACTICALS

1. To find out the acid value of given oil.
2. To find out the saponification value of given oil.
3. To find out the penetration of different soap cakes.
4. To find out the refractive index of sugar solution by refractometer.
5. To estimate the amount of Ash and moisture in the given sample of coal.
6. To determine the normality and strength of the given solution of dilute HCL acid by titrating against 0.1 N Na_2CO_3 solution.
7. To determine the nitrogen content of given fertilizer.

INSTRUCTIONAL STRATEGY

Field visit is must to give details about the various unit operation and processes involved in chemical industries.

RECOMMENDED BOOKS

1. Outline of Chemical Technology by Dryden, East West Press Publication.

2. Chemical Process Technology by Shreeve, McGraw-Hill Publication.

3. A Text Book of Chemical Technology, Vol. I & II by G.N. Pandey. Vikas Publication.

4. Chemical Process and Equipment Design by K.A. Gavhane, Nirali Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	15
2	10	15
3	12	20
4	12	20
5	10	15
6	5	10
7	5	5
Total	**64**	**100**

4.5 POLYMER TECHNOLOGY

L	T	P
4	-	-

RATIONALE

This specialized subject is taught in view of the growing employment potential in the field of polymers. This subject deals with polymer processing techniques and important industrial polymers which will make the diploma holder in chemical engineering confident to join polymer industry.

1. Classification of Polymer (10 hrs)

   Concept of molecular weight (weight average molecular weight, number average molecular weight, viscosity average molecular weight and also effect of molecular weight on propertiers of polymers). Definition of some useful terms as: copolymer, monomer, initiators, free radical, degree of polymerization, elastomers or rubbers, fibers and plastics.

2. Polymer Synthesis (10 hrs)

   - Steps growth polymerization or Condensation Polymerization.
   - Chain-growth polymerization or Addition polymerization.
   - Brief introduction to Co-polymers and copolymerization.

3. Polymerization Techniques (08 hrs)

   Polymerization Techniques - their relative advantages and disadvantages
   - Bulk Polymerization
   - Suspension Polymerization
   - Solution Polymerization
   - Emuision Polymerization

4. Introduction to some Industrial Polymers (16 hrs)

   Structure, properties and use of following polymers
   - Polyester
   - Polyethylene
   - Polystyrene
   - Polypropylene
   - Polyvinyl Chloride
   - Nylon 66, Nylon 6
   - Bakelite
   - Teflon
   - Ureaformeldhyde Resin

5. Additives for Plastics (10 hrs)

- Fillers
- Plasticizers
- Stabilizers
- Coloring Matters
- Cross Linking Agents

6. Polymer Processing Techniques (10 hrs)

- Introduction to Extrusion
- Injection Molding
- Blow molding
- Calendaring

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students. Extension lectures by experts from polymer industries can enrich the students with better inputs regarding the various processes involved for improving the quality of polymer products. Various types of techniques and latest development in polymer industry is essential for complete knowledge of the subject.

RECOMMENDED BOOKS

1. Polymer Science by Gwarikar; New Age International Private Limited

2. Polymer Science by P. Ghosh; Tata, McGraw Hill

3. Polymer Science by Billmeyer

4. Polymer Science and Technology by Joel R. Fried, Prentice Hall of India Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	15
2	10	15
3	08	15
4	16	25
5	10	15
6	10	15
Total	**64**	**100**

4.6 ENERGY TECHNOLOGY

L	T	P
4	-	-

RATIONALE

This subject provides the knowledge of different types of conventional and non conventional sources of energy.

DETAILED CONTENTS

1. Fuels (5 hrs)

   Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection.

2. Solid Fuels (14 hrs)

   Orgin of coal, proximate and ultimate analysis of coal, coal preparation and washing methods, safe storage of coal. Low and High temperature carbonization, products of carbonization, By product coke ovens. Synthetics fuels from coal – Bergius process and Fischer Tropsch process. Gross calorific value and net calorific value determination of catorfic value by bomb calorimeter.

3. Liquid Fuels (5 hrs)

   Orgin of petroleum, refining and distillation of crude oil, uses of petroleum products.

4. Gaseous Fuels (6 hrs)

   Natural gas, manufacture of water gas and producer gas, LPG.
   Furnaces: Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace.

5. Furnaces (12 hrs)

   Classification of furnaces, draught, furnace atmosphere, continuous rotary kiln, blast furnace, glass melting furnace.

6. Alternate sources of Energy (16 hrs)

   - Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation, solar cells.
   - Photosynthesis and biomass conversion systems.

- Wind Energy: Horizontal axis wind turbine and vertical axis wind tusbine.
- Other renewable energy sources such as geothermal and tidal.

7. Power Generation (6 hrs)

Elementary block diagram of Hydraulic Power Plant, Thermal Power Plant and Nuclear Power Plant.

INSTRUCTIONAL STRATEGY

The theoretical knowledge of this subject should be properly imparted to the students for choosing a particular type of fuel for a specific purpose.

RECOMMENDED BOOKS

1. Elements of Fuels, Furnace and Refractions by Gupta O.P., 5th Edition, Khanna Publishers, 2007.

2. Energy Technology – Non conventional Renewable and Conventional by Rao, S. and Parulekar, B.B., 3rd Edition, Khanna Publishers, 2007.

3. Renewable Energy – Environment and Development by Dayal, M., Konark Publishers Private Limited.

4. Solar Energy – Principles of Thermal Collection and Storage by Sukhatme, S.P. 2nd Edition, Tata McGraw Hill Publishing Company Limited, 2006.

5. Fuels and Combustion by Sharma, S.P. and Mohan, C.; Tata McGraw Hill Publishing Company.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	5	5
2	14	20
3	5	10
4	6	15
5	12	20
6	16	20
7	6	10
Total	**64**	**100**

INDUSTRIAL TRAINING OF STUDENTS

(during summer vacation after IV Semester)

It is needless to emphasize further the importance of Industrial Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

This document includes guided and supervised industrial training of a minimum of 4 weeks duration to be organised during the semester break starting after second year i.e. after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A minimum of one visit per week by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An internal assessment of 50 and external assessment of 50 marks have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry.