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 AND REACTION ENGINEERING

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. It is also essential for understanding the kinetics of various reactions, types of reaction vessels and the performance of reactive systems used in the industry.

DETAILED CONTENTS

1. Introduction and Basic Concepts (18 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 and closed systems, calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible isometric, isothermal, isobaric, adiabatic and polytropic process (12 hrs)

3. Second law of thermodynamics – entropy change and its calculations for a closed and open system, carnot cycle and its efficiency and simple numerical calculation of carnot cycle efficiency (10 hrs)

4. Reaction Engineering – single and multiple reactions, elementary and non-elementary reactions, fundamentals of chemical reaction, molecularity, effect of temperature and pressure on equilibrium constant, representation of reaction rate, variables affecting reaction rate, zero order, first order, second order reaction for reversible and irreversible reactions, temperature dependent term of a rate equation, activation energy and temperature dependency, simple numerical problems on reaction rate (14 hrs)

5. Reactors – basic reactor types, construction details, steady state mixed flow reactor, steady state plug flow reactor, general graphical comparison of batch, mixed and plug flow reactor (10 hrs)

INSTRUCTIONAL STRATEGY

Emphasis should be given on problem-solving using simple numericals so as to give in-depth knowledge of the subject. This will make the subject interesting and improve students' involvement in the subject.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering by Ghoshal and Sanyal; Prentice Hall Publication
2. Chemical Reaction Engineering by Levenspiel, John Wiley Publication
3. Elements of Chemical Reaction Engineering by Fogler; Prentice Hall Publication
4. Chemical Engineering Thermodynamics by Dodge; McGraw Hill Publication
5. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, McGraw Hill Publication
6. Reaction Kinetics for Chemical Engineers by Wales; McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	18	25
2	12	20
3	10	15
4	14	25
5	10	15
Total	**64**	**100**

4.3 HEAT TRANSFER

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. Modes of Heat Transfer (32 hrs)

   a) Conduction (12 hrs)

   Fourier's law, Thermal conductivity, Conductance, Flat wall, Multilayer flat wall, Hollow cylinder, Multilayer cylinder, log mean area, geometric mean area and Arithmetic mean area, Introduction to unsteady state conduction, simple numerical problems in S.I. Units.

   b) Convection (12 hrs)

   Natural and forced convection, dimensional analysis, Pi theorem and Rayleigh's method, physical significance of dimensionless number. Reynolds No. Prandtl No., Stanton No., Peclet No., Grashoff No., Seider and Tate's equation, Dittus Boelter's equation, simple numerical problems using Dittus Boelter's equation. Fouling factor, Individual heat transfer coefficient and overall heat transfer coefficient.

   c) Radiation (8 hrs)

   Reflection, absorption and transmission of radiation, Kirchoff's law, Emissive power, Wein's displacement law, Stefen Boltman law, heat transferred by radiation, exchange of energy between two parallel planes of different emissivity, Radiant heat transfer coefficient, Solar radiation, grey surfaces or grey body.

2. Heat Exchanger (12 hrs)

   Log Mean Temperature Difference (L.M.T.D) for parallel or concurrent flow, counter current flow, cross – flow, construction and description of:

a) Double pipe heat exchangers.

b) Shell and Tube heat exchanger.

c) Finned tube heat exchangers.

d) Scale formulation and cleaning devices, Wilson's plot (Simple Numerical Problems).

e) Overall heat transfer coefficient.

3. Evaporators (12 hrs)

Construction and description of:

(i) Horizontal tube type

(ii) Standard vertical type or calendria type:

(a) Natural and forced circulation type.

(b) Entrainment and foam formation.

(iii) Method of feeding evaproators – Forward, backward, parallel and mixed feed, concept of multiple effect evaporation.

4. Insulation (08 hrs)

Purpose of insulation, common insulators, critical thickness of insulation for cylinder and spheres, optimum thickness of insulation, Heat loss from a pipe.

LIST OF PRACTICALS

1. To determine the overall heat transfer coefficient for an open pan evaporator in steady and unsteady state conditions.

2. To determine the amount of steam required in evaporating the solution in open pan evaporator.

3. To determine over all heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.

4. To determine over all heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.

5. To determine over all heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.

6. To determine over all heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.

7. To determine steam economy of a single and double effect evaporator.

8. Measurement of emissivity of test surfaces.

9. To determine the rate of evaporation for a given sample.

10. To determine thermal conductivity of metal.

11. To determine the rate of evaporation in an open pan evaporator.

INSTRUCTIONAL STRATEGY

Heat transfer is fundamental to all chemical process industries. It is extremely important to have good understanding about heat transfer mechanisms. Since this is an important subject, it is very essential for the teacher to make the students very clear about the fundamentals of heat transfer, numerical problems and various heat transfer equipment.

RECOMMENDED BOOKS

1. Unit operation of Chemical Engineering by McCabe and Smith, McGraw Hill Publication.
2. Heat Transfer by Chapman, McMillan Publication.
3. Heat Transfer by NC Adams, McGraw Hill Publication.
4. Heat Transfer by Kern by McGraw Hill Publication.
5. Principles of Heat Transfer by Kreith, Harper and Raw Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	32	50
2	12	20
3	12	20
4	08	10
Total	**64**	**100**

4.4 PROCESS INDUSTRIES

L	T	P
4	-	3

RATIONALE

A chemical engineer, during the professional career, is primarily working in plants engaged in manufacture of various chemical products. It is necessary, therefore, to provide adequate information to the students about the raw materials, the chemistry involved and the outline of manufacturing process of some important chemical products

DETAILED CONTENTS

1. Fertilizer (14 hrs)

   (i) Nitrogeneons fertilizers – ammonia as raw material for manufacturing of urea ammonia nitrate, manufacturing of ammonia, manufacturing of urea (various processes)

   (ii) Phosphorous fertilizer – manufacturing process of super phosphate (SSP) and Diammonium phosphate (DA)

   (iii) Introduction to N, P, K fertilizer and different micro nutrients

2. Sugar Technology (12 hrs)

   (i) Sugar raw materials - Introduction of variety of canes, cane preparation, extraction of cane juice

   (ii) Purification process – classification of juice, settling process, filtration, preparation of thick juice, bleaching process, crystallization of thick juice, separation of crystal from mother liquor, drying of sugar crystal

3. Petroleum Technology (18 hrs)

   Physical properties of crude and products; power number, octane number, cetane number, flash point, fire point, viscosity index, pour point, cloud point, inorganic acidity organic acidity, crude oil characteristics factor – TBP apparatus, gravity mid percent curve, yield curve, equilibrium flash vaporization curve, ASTM distillation characteristics of products, ASTM end points and TBB cut point

   Brief study about desalting and dehydration of crude, topping, atmospheric and vacuum distillation. Brief about the craking and reforming of petroleum

4. Cement Industry (8 hrs)

Definition of cement and Portland cement, major cement industries in India, composition of portland cement, process description raw material, flow sheet and major engineering problems associated with the dry processes for manufacturing of portland cement

5. Oils and Fats (12 hrs)

Introduction to oil and fats, definitions composition, vegetable oil extraction, hydrogenation of vegetable oils, continuous hydrolysis and sapanofication process, flow sheet for continuous process for fatty acids, soaps and glycerine

LIST OF PRACTICALS

1. Sugar cane analysis to measure fibrous content
2. Sugar cane analysis to measure sugar content (brix)
3. To study the characteristics of given crude
4. To evaluate the flash and fire point of a given sample
5. To find the kinematic viscosity by redwood viscometer of a given sample
6. To find the density and API of a given sample
7. To find the smoke point of a given sample
8. To study the batch reactor, their construction detail and working
9. Experiment on CSTR, their construction detail and working
10. Sieve analysis of cement at various stages of production

RECOMMENDED BOOKS

1. Outlines of Chemical Technology by Dryden, East West Press Publication
2. Chemical Process Industries by Shrene, McGraw Hill publication
3. Chemical Technology Vol. I by GN Pandey; Vikas Publication
4. Petroleum Refinary Engineering by WL Nelson
5. Petroleum Processing by RJ Hengsbeck
6. Sugar Cane Hand Book by Miade and Chen
7. Sugar Technology by Peter Honig
8. Cane Sugar Engineering by E Hugot
9. Sugar Cane By-Product Utilization by Paterau

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	**Time Allotted (Hrs)**	**Marks Allotted (%)**
1	14	20
2	12	20
3	18	25
4	08	15
5	12	20
Total	**64**	**100**

4.5 STOCK PREPARATION - I

L	T	P
3	-	-

RATIONALE

Paper is made from fibres after suitable treatment and addition of specific chemicals to impart desired properties. The change of properties of paper based on mixing and blending of various chemicals and combination of fibres will be stressed in this subject.

DETAILED CONTENTS

1. Scope and importance of stock preparation (2 hrs)
2. Introduction of stock preparation section of the paper mills and common terms used therein (2 hrs)
3. Description of different types of chest and agitators used in stock preparation (6 hrs)
4. Theory of beating, refining and its effect on fibre structure and strength properties of paper (6 hrs)
5. Introduction to consistency regulators: kalley, de-zurik, trimby and area. Their working principle, construction and operation , stock proportioning and pulp blending (6 hrs)
6. Different types of laboratory beating equipment like valley beater, PFI mill (4 hrs)
7. Concept of consistency and freeness of pulp and simple numericals based on consistency measurement of freeness and wettability and description of equipment used for measuring (6 hrs)
8. Different types of mill beaters and refiners and their brief introduction about construction and working principles (8 hrs)
9. Operations of beaters, refiners, by hydrapulpers, potchers, savealls, thickeners (8 hrs)

INSTRUCTIONAL STRATEGY

This is one of the important area in the Pulp and Paper industry. Field visit to paper industries is very essential to make the students aware of the latest methods used in stock preparation.

RECOMMENDED BOOKS

1. Handbook of Pulp and Paper Technologies by GA Smook

2. Hand book of Paper Technology by KW Britt

3. Handbook of Paper Technology by C Biermann

4. Pulp and Paper: Chemistry and Chemical Technology Vol. III by JP Casey

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	**Time Allotted (Hrs)**	**Marks Allotted (%)**
1	02	05
2	02	05
3	06	12
4	06	12
5	06	12
6	04	10
7	06	12
8	08	16
9	08	16
Total	**48**	**100**

4.6 PAPER MAKING - I

L	T	P
3	-	3

RATIONALE

The ideas of paper making through machine operation commencing from machine chest to pope reel will be given to the student, emphasizing the maintenance of key elements in this section.

DETAILED CONTENTS

1. Screening and cleaning of stock ahead of the paper machine (5 hrs)

2. Various types of approach flow systems and head boxes, slice, type of slice (6 hrs)

3. General description of modern fourdrinier paper machine, drainage and formation on the fourdrinier machine, working and operation of various accessories of wire part. Brief description of twin wire and twin wire vertical sheet formation systems. (10 hrs)

4. Flow diagram of backwater system and its significance about water conservation and recovery of chemicals (2 hrs)

5. Paper machine wire changing methods, sequence of wire part operation (start up & shut down), duties of machine tender (4 hrs)

6. Sheet transfer operations and working of various vacuum pumps (Nash type, Cycloidal pumps and turbo compressor) (4 hrs)

7. Theory and machanism of wetweb pressing operation and working of various presses, types of press arrangements, press section variables, suction rolls and crowning, press felt treatment and press felt conditioning. (7 hrs)

8. Working operation of cylinder mold machine and its utility for the production of multilayer boards (3 hrs)

9. Simple numerical problems dealing with pulp consistency, chest volume, machine speed, head box level, gsm etc. (7 hrs)

LIST OF PRACTICALS

1. To determine the moisture content of paper sample.

2. To determine the basis weight of paper sample.

3. To compare the gsm of a paper sheet by quadrant scale and by double pan balance.

4. To find out wire side and felt side.

5. To find out Machine Direction (MD) and Cross Direction (CD) of paper

6. To find out the cobb value of paper sheet.

7. To determine the acidity of a paper sheet

8. To plot a curve between percentage moisture content and time under the constant drying condition of a wet paper web

9. To find out the organic and inorganic content (ASH) of a paper sheet

10. Study of lab hand sheet former

11. Study of lab sheet press

12. Study of lab sheet dryer

INSTRUCTIONAL STRATEGY

Visit to paper industry will provide the students with latest techniques of paper making through machine operations.

RECOMMENDED BOOKS

1. Handbook of Paper Technology by KW Britt.
2. Handbook for Pulp and Paper Technologists by GA Smook
3. Paper Making and Paper Board Making, Volume-III by McDonald
4. Pulp and Paper Manufacture, Volume-VII by Benjamin A. Thorp, Michael J. Kocured
5. Paper Machine Manual for Operators by J. Mordon
6. Handbook of Paper Technology by C. Biermann

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	10
2	06	15
3	10	20
4	02	04
5	04	08
6	04	08
7	07	15
8	03	05
9	07	15
otal	**48**	**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.