4.1 POLYMER PROCESSING TECHNIQUES - I

L	T	P
4	-	6

RATIONALE

The purpose of this subject is to equip the students with the knowledge of plastic processing machineries and injection moulding. This subject develops the competence of the students in major industrially practiced processing techniques.

DETAILED CONTENTS

1. Introduction to polymer processing. Polymer melt flow, melt flow processes (6 hrs)

2. Preheating/drying of plastic raw materials before processing. (6 hrs)

3. Compounding Equipments: (12 hrs)

   Kneaders, High Speed ,Mixer, Two Roll Mill, Banbury Mixer, Usage in polymer industry

4. Conversion Techniques: (16 hrs)

   Preliminary ideas of extrusion, injection molding, blow molding, rotational molding, compression and transfer molding taking examples of commonly used products made by each process.

5. Selection creteria for injection molding machine. Basic principles of operations of injections moulding machinery/types of injection moulding machines, description with detailed construction (6 hrs)

6. Defects in injection molding products, their causes and remedies (4 hrs)

7. Printing techniques - flexographic printing, gravure printing, pad printing, screen printing, hot stamping (8 hrs)

8. Post processing operation - engraving, metallisation, painting, electroplating, encapsulation (6 hrs)

LIST OF PRACTICALS

1. To draw the layout of plastic processing laboratory
2. To produce small components on hand operated injection molding machine (at least 10 components each on 2/3 different moulds)
3. To study the specifications of automatic injection molding machine
4. To study the specifications of CNC injection molding machine
5. To study Rotogravure & Flexographic Printing
6. To do printing with pad printing machines
7. To produce small components on vertical hydraulic injection moulding machine

INSTRUCTIONAL STRATEGY

In plastic industry, the basic raw material is polymer. The purpose of the subject is to give knowledge about the polymers, processing behaviour and their applications. Hence, visit to local polymer industry should be organised.

RECOMMENDED BOOKS

1. Polymer Processing by DH Morton Jones, published by Chapman and Hall, London
2. Plastic Engineering Handbook by Joel Frados, published by Chapman and Hall, London, UK,
3. Plastic Engineering Handbook by ML Berins, published by Chapman and Hall, London, UK,
4. Injection Molding Handbook by Rosato, Published by Tata McGraw Hill Co., New Delhi
5. Injection Molding Handbook by AS Athalye, Published by Tata McGraw Hill Co., New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	10
2	06	10
3	12	18
4	16	24
5	06	10
6	04	06
7	08	12
8	06	10
Total	**64**	**100**

4.2 POLYMERIC MATERIALS AND PROPERTIES

L	T	P
4	-	-

RATIONALE

This subject gives a detailed description of polymeric materials in the category of thermoplastics, thermo sets and elastomers. This subject enables the students in acquiring the knowledge for selection of right type of materials for processing in order to make the product. Various polymeric materials can be identified with property assessments.

DETAILED CONTENTS

1. General characteristics of thermoplastics, thermosets and elastomers. Crystalline and amorphous polymers and their relation to processing and applications (4 hrs)

2. Thermoplastics

   General properties and applications of the following: (16 hrs)

   - Polyethylene (PE)
   - Linear low density polyethylene (LLDPE)
   - Low density Polyethylene (LDPE)
   - High density polyethylene (HDPE)
   - PVC
   - PP, PC
   - PS-GPPS, HIPS
   - Nylons - Nylons 6, 66
   - PMMA
   - ABS, SAN
   - Cellulose plastics
   - PET, PBT.

3. Thermosetting resins (12 hrs)

   a) Synthesis, properties and applications of phenol resins, urea, melamine resins, poly urethanes.

   b) Properties and applications of silicone resins, epoxy resin and unsaturated polyesters.

4. Elastomers (14 hrs)

   General Properties and Applications of NR, SBR, Polyisoprene, Chloroprene, Polybutadiene, EPDM, Nitrile rubber, Silicone rubber and Elastomers

5. Engineering Thermoplastics (8 hrs)

Poly Ether Ether Ketone (PEEK), Poly phenylene Oxide (PPO), Poly Acetals, Polysulphones (PSO), Poly Tetra Floro Ethylene (PTFE), Liquid Crystalline Polymer (LCP)

6. Reinforced Plastics (10 hrs)

Principles of composite reinforcement, effect of reinforcement on strength of plastics, Role and nature of binders and coupling agents, properties and preparation of graphite and boron fibers. Miscellaneous fillers (talc, mica, glass beads), Properties and application of FRPs (un-saturated polyesters, epoxies, PU, nylon).

INSTRUCTIONAL STRATEGY

In plastic industry the basic raw material is polymer. The purpose of this subject is to give the knowledge about the material, processing behaviour, applications, grades. That will help them to select the most suitable material for particular product manufacturing. So at one time one polymer should be taught and products made from that should be shown in the class room if possible.

RECOMMENDED BOOKS

1. Polymer Material by J.A. Brydson, Published by M/S Butterworth Heinemann, Linacre House, Jordan Hill, UK
2. Organic Chemistry of Polymers by Saunders
3. Polymer Science and Technology by P Ghosh, Published by M/S Chapman and Hall, London
4. Polymer Materials - I Ed. Published by Polymer Research Centre, Bangalore, M/S Tata McGraw Hill, Publishing Co; New Delhi
5. Polymer Materials - II Ed. Published by Polymer Research Centre, Bangalore
6. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, McGraw Hill.
7. Chemical Engineering Thermodynamics by K.V. Narayanan, Prentice Hall India.
8. Chemical Engineering Thermodynamics by YVC Rao

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	04	05
2	16	25
3	12	20
4	14	20
5	08	15
6	10	15
Total	**64**	**100**

4.3 HEAT TRANSFER

L	T	P
4	-	3

RATIONALE

The subject enables the students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performance 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 Arthmatic 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, physical significance of dimension less number. Reynolds No, Prandlt No., Nusselt No., Stanton No., Peclet No., Grashoff No., Dittus Boelter's equation-simple numerical problems using Dittus Boelter equation. Fouling factor. Individual heat transfer coefficient and over, all 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 transfered 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-Tempature.-Difference(L.M.T.D.) for parallel or concurrent -flow, counter-current-flow, cross -flow, construction and description of

   i) Double pipe heat exchangers.
   ii) Shell & Tube heat exchanger
   iii) Finned tube heat exchangers.
   iv) Scale formulation and cleaning devices, Wilson's plot (Simple Numerical Problems).
   v) Overall heat transfer coefficient

3. Evaporators (12 hrs)

Construction and description of
i) Horizontal tube types
ii) Standard vertical type or calendria type.
(a) Natural and forced circulation type.
(b) Entrainment and foam formation.
(c) Method of feeding evaproators-Forward,Backward & cross, mixed multi effect evaproation.

4. Insulation (08 hrs)

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

LIST OF PRACTICALS

1. To determine the over all 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 'U' for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current

4. To determine 'U' for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current

5. To determine 'U' 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 'U' 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 a an open jar evaporator

INSTRUCTIONAL STRATEGY

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; 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 MASS TRANSFER

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 (02 hrs)

2. Diffusion (10 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 equimolar 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. Distillation (12 hrs)

   Relative volatility, vapour liquid equilibrium, various distillation methods, flash distillation, continuous, fractionating column with details and identification of different parts, flash distillation, steam distillation, introduction to azeotropic, extractive distillation, different types of distillation columns, concept of flooding, weeping, entrainment and loading in distillation columns

   (Qualitative treatment only, final expressions and the physical meaning of terms therein – derivations excluded)

4. Gas Absorption (12 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.

5. Humidification and Dehumidification (10 hrs)

Definition of humidity, saturated gas, relative humidity, percentage humidity, humid heat, humid volume, dew point, total enthalpy, 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

6. Leaching and Extraction (8 hrs)

Importance of leaching and extraction, leaching equipment, boll man extractor, plate tower, packed tower, spray tower, mixer settler extraction system

7. Drying (10 hrs)

Definition, industrial application, moisture content, wet and dry basis, equilibrium moisture, bound, unbound, free moisture, batch drying; direct driers, tray driers, two track driers, rate of drying curve, continuous drying, turbo type drier, rotary driers

LIST OF PRACTICALS

1. To study the rate of drying in a vacuum dryer
2. To determine the pounds of volatile compounds distilled per unit pounds of steam distlled in a steam distillation operation
3. To study the rate of drying in rotary dryer
4. To determine drying rate for a wet material
5. To study packed tower in various industries
6. To study various extractors in solvent extraction plant
7. To study a spray pond in a sugar and other industries for cooling system
8. To find out the drying characteristics of given sample and draw drying rate curve by infra-red moisture meter and rapid moisture meter.

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	02	05
2	10	15
3	12	20
4	12	15
5	10	15
6	08	15
7	10	15
Total	64	100

4.5 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 system used in industry.

DETAILED CONTENTS

1. Introduction and Basic Concepts (12 hrs)

   Systems, processes and surroundings, homogenous and heterogeneous systems, closed, open and isolated, extensive, and extensive properties, state and path functions. Concept of internal energy, enthalpy, entropy, free energy and equilibrium equation of state, ideal gas law, Vander Waals 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 (12 hrs)

   Statement of first law of thermodynamics, use of steam tables, calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible, isothermal, adiabatic and polytrophic processes. Isobaric T-V, P-V and P-T diagrams

3. Second law of Thermodynamics (18 hrs)

   - Statement of second law of thermodynamics: Kelvin plank statement and carnot statement, carnot cycle and its efficiency, concept of entropy and entropy change for closed and open system.

   - Heat pump and heat engine (coefficient of performance and efficiency).

   - Reversible and irreversible process. Thermodynamic temperature scale.

4. Third law of Thermodynamics, Statement only (02 hrs)

5. Application of Second law of thermodynamics (12 hrs)

   Refrigeration, vapor compression and absorption refrigeration, types of compressors, reciprocating air compressors, single stage compressor, isentropic efficiency of compressor.

6. Phase Equilibrium (08 hrs)

   Raoult's law, Gibb's phase rule, vapor liquid equilibrium, dew point and bubble point, calculations for two component systems.

INSTRUCTIONAL STRATEGY

Lot of stress 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	12	20
2	12	20
3	18	25
4	02	05
5	12	20
6	08	10
Total	**64**	**100**

4.6 COMPUTER AIDED MOULD DESIGN

L	T	P
-	-	3

RATIONALE

In this practical subject, the students are required to learn the basics of software such as Mechanical Desktop, Mould Creater, Mould Flow etc. and further to design molds for given components using these software.

DETAILED CONTENTS

1) Surface Modeling

   Various types of surface creation like mesh, ruled surfaced, edged surface, tabulated surface etc. using MDT or AutoCAD.

2) Solid Modeling:

   Various commands like Extrude, Revolve, Blend, Helix, Sweep, Holes, Ribs and Bosses etc. and practice these command making 3D design of different plastics.

3) Analysis and Report generation :

   For calculating stresses on various designs and structures.

4) Interface with Mold-flow and Mold Creator software.

5) Design of various components used in plastic industries and lab exercise

INSTRUCTIONAL STRATEGY

Students should gather practical knowledge about designing of electrical switches, plastic bottles and other liquid packaging plastic containers.

RECOMMENDED SOFTWARE

1. Auto CAD latest version
2. Solid Works
3. Mold-flow/ Mold Creator

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.