4.1 PLASTIC PROCESSING TECHNIQUES-1

L T P
4 - 4

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 processes (4 hrs)

2. Preparing plastic raw materials before processing. (4 hrs)

3. Conversion Techniques: (10 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.

4 Selection creteria for injection molding machine, basic principles of operations of injections moulding machinery/types of injection moulding machines, description with detailed construction (8 hrs)

5 Parts and functions, general specification, construction, startup and shutdown procedure, cylinder nozzles, interaction of molding variable, optimization of cycle flow. (10 hrs)

6 Introduction ,principles, process variables, mechanical, electrical, electronic control system. (10 hrs)

7 Injection molding of thermosets. (4 hrs)

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

9 Printing techniques - flexographic printing, gravure printing, pad printing, screen printing, hot stamping (6 hrs)

10 Post processing operation - engraving, metallisation, painting, electroplating, encapsulation (4Hrs)

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,construction and working principal of automatic injection molding machine.
4. To produce components of automatic injection molding machine
5. To study the specifications,construction and working principal of CNC injection molding machine
6. To produce components of CNC injection molding machine.
7. To study rotogravure and flexographic printing
8. To print components with pad printing machines
9. To produce small components on vertical hydraulic injection moulding machine

INSTRUCTIONAL STRATEGY

Industrial visit should be organized.

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	4	6
2	4	6
3	10	16
4	8	12
5	10	16
6	10	16
7	4	6
8	4	6
9	6	10
10	4	6
Total	**64**	**100**

4.2 PLASTIC TESTING, CHARACTERISATION & QUALITY CONTROL

L	T	P
3	-	3

RATIONALE

It is necessary to test the raw materials and the products during various stages of their manufacture to control the quality. This subject provides the essential knowledge and skills to the students for assessing its potential application by evaluating various associated properties.

DETAILED CONTENTS

Testing

1. Testing (6 hrs)

   Overview of various testing methods and organizations such as ASTM, BIS, DIN and ISO, Test specimen preparation : milling, punching, template, cutting from sheets or films

2. Identification of Plastics (4 hrs)

   Visual, burning, heating, elemental analysis, group

3. Physical properties (4Hrs)

   Specific gravity, Water absorption and solvent resistance

4. Mechanical Properties (6Hrs)

   - Tensile strength, impact strength (Izod & Charpy),_flexural strength, fatigue resistance, compression strength, tear test
   - Dynamic Mechanical properties - creep and stress relaxation, Dynamic Mechanical analysis (DMA), Oscillatory measurements.
   - Hardness, Shore and Rockwell hardness, Abrasion resistance.

5. Thermal properties (6 hrs)

   Melting point, Vicat softening point, heat distortion temperature

6. Electrical properties (6 hrs)

   Dielectric strength, Arc resistance, Insulation resistance, Volume and surface resistivity

7. Optical properties (4Hrs)

   Light transmittance, Haze, Gloss, refractive index

8. Polymer Rheology (6 Hrs)

Melt flow index, capillary rheometer, cone and plate rheometer

9 Quality Control (6 hrs)

Basic concept of statistical quality control, Visual inspection, Testing of a finished product, Analysis of test data to control finished product in relation to service requirement, Special tests on individual products to improve the quality

LIST OF PRACTICALS

1. To carry out volume and surface resistivity test on given samples of plastic
2. To determine the tensile strength, flexural strength of plastics specimen.
3. To determine impact strength of different plastics specimen.
4. To determine hardness (Shore and Rockwell) of different specimen of plastics.
5. To carry out dart impact test on given plastics films/laminates.
6. To determine the Melt Flow Index of given samples of plastics.
7. To carry out
   (i) heat detection test on given samples of plastics.
   (ii) Vicat softening point test on given samples of plastics
8. To measure gloss of plastic specimen.
9. To carry out environmental stress cracking resistance test on given samples of plastics.

INSTRUCTIONAL STRATEGY

Different articles or products should be given to the student to do testing and quality control

RECOMMENDED BOOKS

1. Testing of Plastics by Roger Brown; Blackwell Publishing Ltd Oxford, UK

2. Plastics - Materials and Processing by Abrentstrong, Prentice Hall of India publication, New Delhi, 2000

3. Plastics Testing by Vishu Shah, published by M/S Vishu Shah Publisher, New York

4. Identification of Plastics by CIPET, published by Kluwer Academic publishers, New York

5. Identification of Plastics by published by M/S AS Athalye, London lliffe Books Ltd., New York.

SUGGESTED DISTRIBUTION OF MARKS

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

4.3 FUNDAMENTALS OF CHEMICAL ENGINEERING

L	T	P
4	-	4

Rationale

A thorough knowledge of unit operations is essential for the study of polymer science and plastic processing. This course acquaints the students with the fundamentals of thermodynamics, heat transfer and mass transfer and mechanical operations.

DETAILED CONTENTS

1. Heat Transfer (16 hrs)

Modes of Heat Transfer, Fourier's law of heat conduction, Conduction across Single ,Composite and Cylinder wall ,Convection -Heat transfer by natural & forced convection, Individual and overall heat transfer coefficients. LMTD, Heat Exchanger Equipment (Double pipe, Shell and Tube Heat Exchanger)

2. Thermodynamics (16 hrs)

Thermodynamic system and surrounding. Total and specific property, cycle, Homogenous and heterogeneous system, thermodynamic equilibrium, Equation of State, Three Laws of Thermodynamics, Thermodynamic process-Isometric, Isothermal, Isobaric, Isoentropic, Adiabatic & Polytropic, Concept of Gibbs free energy, phase change, Roults law

3. Mass Transfer (16 hrs)

Principle's of Diffusion, Mass Transfer Coefficient, Application of Mass Transfer-Distillation(Simple and Steam), Drying-Principle and definition of Drying, Equipment for Drying, Humidification-Humidity and Saturation, Dry & Wet bulb Temp., Percentage Saturation, Dew Point, Humid Volume & Humid Heat

4. Mechanical Operations (16 hrs)

Size Reduction law, Crushers & Grinders, Screening & Screening Equipment, Filtration-Principle and filtration equipment (Filter press, Rotary drum filter, and Centrifugal filter), Cyclones Separators

LIST OF PRACTICALS

1. To measure the thermal conductivity of insulating materials
2. To determine overall heat transfer co-efficient in, a double pipe heat exchanger in parallel and counter flow heat exchange modes
3. To measure diffusivity of solids in liquid or gas
4. To perform an experiment on batch distillation unit.
5. To perform an experiment on humidification column.
6. To carry out the calibration of a thermocouple.
7. To carry out the sieve analysis of a product obtained from size reduction equipment such as ball mill, grinder etc.

8 To perform an experiment on cyclone separator

9 To find the rate of filtration using filter press

10 To perform an experiment on a mixer for liquid-liquid mixing

11 To perform an experiment on a mixer for solid-liquid mixing

INSTRUCTIONAL STRATEGY

Polymer based industrial problems (numerical) should be given as assignments to make students acquaint with basic principles of unit operations.

RECOMMENDED BOOKS

1. Heat & Mass Transfer by D S Kumar
2. Mass Transfer Operations by Treybal
3. Unit Operations-II by K. A. Gahane
4. Thermodynamics by P.K. Nag
5. Chemical Engineering Thermodynamics by KV Narayanan
6. Unit Operations by McCabe and Smith

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**

4.4 POLYMER SCIENCE & TECHNOLOGY-II

	L	T	P
RATIONALE	**4**	**-**	**3**

The subject is designed to enable the students to acquire basic knowledge of polymer chemistry and polymer physics for better understanding of polymer related subjects. This will help the students in identifying different polymeric materials to be processed in the industry and determine their quality based on physical and chemical properties.

DETAILED CONTENTS

1. Degree of polymerization, molecular weight and molecular weight distribution, ploydispersity, measurement of molecular weight by dilute solution, group analysis, viscometry, membrane osmometry, vapourphase osmometry, cryoscopy, ebulliometry, light scattering, centrifugation, Gel permeation chromatography.

(14 hrs)

2. Physical states of polymers - amorphous and crystalline behaviour. Polymer dissolution - dissolution and solvent selection for polymers, thermodynamics of polymer solutions, solubility parameter (6 hrs)

3. Thermal transitions in polymer - Glass transition temperature, its importance, Factors influencing Glass transition temperature (Tg), Techniques for its determination, melting temperature, relationship of polymer properties with structure (6 hrs)

4 Condensation Polymerization; Concept of functionality and Carother's equation for condensation - polymerization, relation between conversion and degree of polymerization, gelation effect and auto acceleration phenomenon (6 hrs)

5 Free radical polymerization, different types of initiators, inhibition, retardation, chain transfer agents etc, ceiling temperature, ionic polymerization, Ziegler-Natta polymerization (12 hrs)

6 Importance of copolymers, different types of copolymers, copolymer equation, reactivity ratios (6 hrs)

7 Techniques of polymerization: bulk, solution, emulsion and suspension, their relative advantages and disadvantages, introduction to Rheology and Visco-elasticity, time dependent and time independent viscosity behaviour; power law fluids; Zero shear viscosity, Maxwelll and Voigt models of visco-elastic materials (14 hrs)

LIST OF PRACTICALS

1. To identify at least 3 given polymers by following methods:
   - Visual examination
   - Specific gravity test
   - Melting and odour test
   - Burning test
   - Solubility test
   - Softening and melting point test
   - End group analysis
2. To determine boiling point of at least 2 given monomers (such as styrene).
3. To determine refractive index of 2 given monomers to establish its purity.
4. To determine melting point of 3 given polymers.
5. To determine water absorption of various plastics (at least 3 samples).
6. To determine the bulk density of 2 given polymers.
7. To synthesize phenol formaldehyde resin and to determine its gel time.
8. To determine viscosity and average molecular weight by dilute solution viscometry.

INSTRUCTIONAL STRATEGY

Industrial visit or a laboratory scale polymerization should be shown to the students.

RECOMMENDED BOOKS

1. Polymer Chemistry by Paave, Published by Tata McGraw Hill Co., New Delhi.
2. Test Book of Polymer Science by Billmeyer, published by M/S John Wiley & Sons; New York
3. Polymer Science and Technology by Joel R., published by CRC Press, London
4. Polymer Science by Gowariker Fried, Prentice Hall of India publication, New Delhi, 2000
5. Principles of Polymerization by Odian, published by M/S Technomic Publishing Co, London

SUGGESTED DISTRIBUTION OF MARKS

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

4.5 PLASTIC MATERIALS AND PROPERTIES-II

L	T	P
3	-	-

RATIONALE

This subject gives a detailed description of advanced engineering and speciality polymeric materials in category of thermoplastics, thermosets and elastomers. The students acquires the knowledge of new and advanced polymers so that he/she can select the right type of materials for processing to make the product.

DETAILED CONTENTS

1. Engineering thermoplastics – Poly Ether Ether Ketone (PEEK), Poly Phenylene Oxide (PPO), Poly acetals (POM), Polysulphones(PSO) ,Poly Tetra Floro Ethylene (PTFE), Liquid Crystalline Polymer (LCP) (10Hrs)

2. Special materials like Poly Ether Sulphones(PES), Poly Phenylene Sulphide (PPS),Polyarylates. (6Hrs)

3 Reinforced plastics - 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 applications of FRPs (un-saturated polyesters, epoxies, PU, nylon), Nanocomposites (use of CNT, graphite, clay, silica, nano particles)

(12Hrs)

4 Polyblends and alloys - Definition, advantages of polymers, blends and alloys, role of composition, properties and applications of parameters for compability, interpenetrating polymer networks,PVC- Nitrile rubber, ABS-PVC and PP-EPDM

(10Hrs)

5 Preliminary concept of new materials such as conducting polymers, Biopolymers, opto-electronic plastics, nano-polymeric materials, , polymer concretes (10Hrs)

INSTRUCTIONAL STRATEGY

In plastic industry the basic raw material is polymer. The purpose of this subject is to give the knowledge about the material, grades, processing behavior and applications. That will help the students 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 Science & Technology by Premamoy Ghosh, Published by Tata McGraw Hill Co., New Delhi

2 Polymer Blends and Alloys by Arends, published by M/S Hanser Publishers, New York

3 Polymers Science & Technology by JR Fried, published by M/S Hanser Publishers, New York

4 Plastics Materials by Brydson, PHI Publication, M/S Vikas Publishing, New Delhi

5. Engineering Polymers by Dyson, PHI Publication, published by Khanna Publishers, New Delhi

6 Polymer Materials and Processing by Jean Michael Charrier, published by M/S Hanser Publishers, New York

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	20
2	6	10
3	12	30
4	10	20
5	10	20
Total	**48**	**100**

4.6 COMPUTER AIDED MOULD AND DIE 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 & 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
4. PRO-E, CATIA
5. IDEAS

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.