PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To provide an interdisciplinary specialization in master degree with emphasis on materials, engineering and fundamentals of polymers and their processing and to produce employable post graduates with knowledge and competency in scientific and engineering aspects of polymers, plastics, additives and compounding.

II. To impart the concepts of synthetic resins, composites, engineering plastics, adhesives and conducting polymers and their applications in industries and to provide the overall knowledge on mould manufacturing, characterisation, quality control and recycling through theory and practical.

III. To gain knowledge on biodegradable polymers, thermoplastics elastomers and fibres in engineering applications and to provide comprehensive knowledge on plastics testing, composite product design and plastic waste management.

PROGRAMME OUTCOMES (POs)

1. Engineering Knowledge: To select and apply the knowledge, techniques, skills and modern tools of plastics technology to broadly define. To apply and integrate knowledge from four elements i.e., polymer structure, properties, process and performance to solve the industrial problems and also to develop an entrepreneur skill.

2. Problem Analysis: To choose and apply the knowledge of mathematics, science, engineering and technology to polymers and plastics technology problems that requires the application of principles and applied procedures or methodologies. To impart knowledge of the topics of inter-disciplinary research, problem identification, formulation and solution in plastics technology.

3. Design/development of solutions: To conduct standard tests and measurements to analyze and interpret the experimental results for improving the processes.

4. Conduct investigations of complex Problems: To design systems, components or processes for broadly defined plastics technology problems.

5. Modern Tool Usage: To use the techniques, skills and modern engineering tools necessary for engineering practice to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

6. The Engineer and Society: To understand the need and engage in self-directed continuing professional development. Learn future technologies through acquired foundation skills and knowledge and employ them in industry and business environments.

7. Environment and Sustainability: To understand the impact of Plastics technology solutions in a societal and global context.

8. Ethics: To demonstrate an understanding of and a commitment to professional and ethical responsibilities, including a respect for diversity.
9. **Individual and team work**: To function effectively as a member or leader on a technical team. Professionally skilled for higher studies in research institutions and to work in plastics industries.

10. **Communication**: To communicate effectively regarding broadly defined Plastics technology activities.

11. **Project Management and Finance**: To Demonstrate knowledge and understanding of engineering and management principles and apply to polymer engineering work

12. **Life-long learning**: exhibit a commitment to quality, timeliness and continuous improvement.

PEO/PO Mapping

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# ANNA UNIVERSITY:: CHENNAI 600 025
## AFFILIATED INSTITUTIONS
### M.TECH. PLASTICS TECHNOLOGY
#### REGULATIONS – 2017
##### CHOICE BASED CREDIT SYSTEM
###### I TO IV SEMESTERS CURRICULUM AND SYLLABUS

## SEMESTER I

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**TOTAL CREDITS: 75**

### LIST OF ELECTIVES

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**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

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OBJECTIVES:

- This course is designed to provide a solid foundation on topics in probability, various numerical and statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles behind the numerical solution of differential equations, probability, statistics, testing of hypothesis and queuing models. This will also serve as a precursor for future research.

UNIT I  NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS  12
Solution of first order ordinary differential equation - Taylor's method - Euler's method - Runge-Kutta method of fourth order - Predictor – Corrector Methods - Milne’s and Adam's – Bashforth methods - Introduction to numeric use of the above techniques in plastics engineering and calculations.

UNIT II  NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT III  PROBABILITY AND STATISTICS  12
Probability – Addition theorem - Multiplication theorem - Conditional probability – Baye’s theorem - Distribution functions - Binomial distribution - Poisson distribution - Normal distribution - Uniform distribution - Curve fitting – Fitting a straight line and second degree curve - Fitting a non linear curve - Correlation and regression.

UNIT IV  QUEUEING MODELS  12
Poisson process – Markovian queues – Single and multiserver models – Little’s formula – Steady state analysis – Self service queue.

UNIT V  TESTING OF HYPOTHESIS  12
Sampling distribution – Large sample and small samples - Testing of null hypothesis - Type I and Type II errors - "t" test and Chi square test - Goodness of fit - Fisher’s "F" test.

TOTAL :  60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Theories and methods in solving both Ordinary Differential and Partial Differential Equations numerically
- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Distributions and its properties, correlation, regression.
- Use statistical tests in testing hypotheses on data.
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.
REFERENCES:

OBJECTIVES
- To understand the mechanism of polymerization, techniques of polymerization and the significance of different molecular weight averages.
- To provide in depth knowledge about different kinds of plastic materials based on their structure and properties
- To make the student familiar about properties and end application of different plastics materials

UNIT I POLYMER CHEMISTRY

UNIT II COMMODITY PLASTICS
Sources and Manufacture of raw materials - Methods of manufacture of Polymer, General Properties and applications of Polyethylene - Polypropylene and their copolymers-Vinyl Polymers and Co-polymers-Polystyrene and Copolymers-Acrylic and copolymers-Cellulose Polymers.

UNIT III ENGINEERING PLASTICS
Sources and Manufacture of raw materials, Methods of Manufacture of Polymer, General Properties and applications of Acrylonitrile Butadiene Styrene -Polyamides (PA-6,PA- 66,PA-6,10,PA-11&12)- Polycarbonates- Polyacetal& Copolymers- Thermoplastic Polyesters (PET&PBT)-Polyphenyleneoxide-Polysulfones- Fluoropolymers (PVF,PVDF,PTFE,PCTFE) – Thermoplastic Polyurethane.

UNIT IV SPECIALITY PLASTICS
Sources and Manufacture of raw materials, Methods of manufacture of Polymer, General properties and applications of Polyphenylene Sulphide-Polyphenylene ether Polyetherether ketone – Polyimide and related polymers-Liquid Crystal Polymers- Conductive Polymers– Plastic alloys and blends.

UNIT V THERMO SETTING PLASTICS
OUTCOMES
At the end of the course, the student should be able to
- Apply suitable polymerisation technique to prepare the plastics as per the requirement.
- Select the plastic materials for particular end use based on properties.
- Predict the behaviour of different kinds of plastics material based on their structure and property relationship.

REFERENCES

PA5102 ADDITIVES AND COMPOUNDING

OBJECTIVES
- To know about various additives like Lubricants, Fillers, Fibres, flame retardants, colourants, anti-oxidants, UV-stabilizers, plasticizers, anti-blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- To understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- To select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.

UNIT I INTRODUCTION TO ADDITIVES
Introduction-Technological Requirements – Classification-Chemistry and Mechanism-Selection Criteria-General effect on Properties-Evaluation and functions of additives.

UNIT II ADDITIVES

UNIT III COMPOUNDING TECHNIQUES
Selection of Polymers and Compounding ingredients-General objectives-possibilities and limitations of mixing and compounding-Methods of incorporation of additives into polymer materials.

UNIT IV COMPOUNDING EQUIPMENTS
UNIT V  END USE MARKET FOR PLASTICS

Principles of Material selection including consideration of conventional materials competitive with plastics - Case studies on material suitability (e.g., Plastic Gears, Feeding Bottle, Bowels for microwave ovens). Survey and uses of plastics with reasons for their importance in major industries like, Agriculture, Packaging, Building, Transport, Electrical, Electronics and Telecommunications, Medical and Furniture.

TOTAL : 45 PERIODS

OUTCOMES
At the end of the course, the student should be able to

- Select the suitable additive as per requirement.
- Identify the suitable compounding techniques to make different grades of Plastics compounds
- Formulate the compound to solve the environmental related problems.

TEXTBOOKS

REFERENCES

PA5103  PLASTICS TESTING TECHNOLOGY I

OBJECTIVE

- To develop the knowledge of National & International standards for testing methods.
- To create the knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastic materials.
- To enable the students to identify and compare the properties of different plastics materials.
- To enable the students to learn about the property of the plastic material for several applications.
UNIT I
Consideration of importance of testing for identification of plastics-Determination of necessary manufacturing conditions-Assessment of properties of finished products in relation to service requirements.

UNIT II
Standard and specifications - National and International standards-BIS, ASTM, ISO & NABL.

UNIT III
Identification of common plastics materials by simple tests e.g., visual inspection, density, effects of heat, combustion and solvents, analysis with common solvents.

UNIT IV
Preconditioning and test atmosphere - Testing of Mechanical properties. Thermal properties., Optical properties.

UNIT V
Testing of Electrical properties, Permeability Properties and Rheological properties.

TOTAL : 45 PERIODS

OUTCOME
Upon completion of this course,
- Ability to test the plastics materials for its chemical, mechanical, electrical, optical, thermal, and permanence properties as per the standard.
- Ability to identify the plastic materials by reverse engineering for some specified applications with the knowledge of testing.

REFERENCES

PA5111 PLASTICS PROCESSING LABORATORY I

OBJECTIVE
- To gain practical knowledge about hand operated injection moulding, semi automatic & automatic injection moulding machine, Blow moulding process.
- To identify defect, causes & remedies of the process.
- To select the suitable process parameters for a particular process.

EXPERIMENTS
1. Injection Moulding (Hand Operated )
2. Injection Moulding (Semi-Automatic)
3. Injection Moulding (Automatic)
4. Extrusion Processes
5. Compression Moulding (Hand Operated)
6. Compression Moulding (Semi Automatic)
7. Blow Moulding (Hand Operated)
8. Scrap Grinding

LABORATORY REQUIREMENTS
1. Injection moulding machine (conventional) - 2 Nos.
2. Plastic tube extrusion machine - 1 No.
4. Compression moulding machine - 1 No.
5. Blow moulding machine (conventional) - 1 No.

TOTAL: 60 PERIODS

OUTCOME
- Understand all the manufacturing techniques, machine components, their function and setting of process parameter.
- Analyze the cycle time and process parameter to overcome the trouble shoots.

REFERENCES

PA5112 PLASTICS TESTING LABORATORY I

OBJECTIVE
- To create the knowledge and in hand practice for operating the injection moulding and Compression moulding machine to prepare specimens for various testing of plastics materials as per the ASTM standards.
- To prepare sheet specimens by Contour cutting & Punching
- To get practice in testing the Physico-mechanical properties of plastic materials.
- To learn about the compounding of plastics materials.

EXPERIMENTS
Chemical Lab: Identification of Plastics – Viscosity and Molecular Weight Determination – Determination of K-value for PVC.
Specimen Preparation Lab: Specimen preparation using injection moulding machine – Compression moulding machine – Two roll mill and Contour cutter.
Demonstration: Scrap grinder – Blender 11
Physio-Mechanical Lab: Tensile strength – Flexural strength – Compression strength – Tear strength - Impact strength – Hardness

TOTAL : 60 PERIODS

OUTCOME
- Ability to prepare specimen through injection & Compression moulding and by contour cutting & punching with the shape & size as per ASTM standards for various testing of Plastics Materials.
- Ability to test the Chemical & Mechanical properties of plastics materials in the laboratory.
- Ability to select suitable compounding equipment as per the requirement.

LABORATORY REQUIREMENTS

Chemical Laboratory
1. Viscometer - 1 No.
2. Melting point apparatus - 1 No.
3. Carbon black content tester - 1 No.
5. Brookfield viscometer - 1 No.
6. PH meter - 1 No.

Specimen Preparation Laboratory
1. Injection moulding machine - 1 No.
2. Compression moulding machine - 1 Nos.
3. Two roll mill - 1 No.
4. Contour cutter - 1 No.
5. Scrap grinder - 1 No.
7. Physio-mechanical Laboratory
8. Universal testing machine - 1 Nos.
9. Tear strength tester - 1 No.
10. Impact strength tester - 1 Nos.
13. Rockwell Hardness tester - 1 No.
15. Folding endurance tester - 1 No.
16. Burst strength tester - 1 No.
17. Humidity chamber - 1 No.
18. Gas permeability tester - 1 No.
19. Sieve analysis apparatus - 1 No.

REFERENCES
PA5113 POLYMER SYNTHESIS AND CHARACTERISATION LABORATORY

OBJECTIVES
- To provide hands on experience on various polymerization techniques.
- To make the student understand simple experimental procedures to determine molecular weight and molecular weight distribution of polymers.
- To make the student familiarize with the thermal properties of polymers.
- To make the student understand simple techniques to identify the plastic materials.

LIST OF EXPERIMENTS
1. Identification of Plastics materials.
2. Density determination.
3. Bulk polymerization - Preparation of polymethyl methacrylate.
4. Solution Polymerization - Preparation of polyacrylamide.
5. Preparation of Phenol-Formaldehyde, UF and MF resins.
6. To study auto acceleration by solution polymerization method.
7. Synthesis of copolymers by Emulsion, Bulk, solution & suspension Polymerization.
9. End group analysis.
10. Determination of acid value of a resin.
11. Study of Molecular weight distribution (GPC).
12. Determination of cure of a phenolic moulding (percentage acetone soluble matter).

TOTAL: 60 PERIODS

OUTCOMES
1. Ability to measure viscosity of polymer solutions.
2. Ability to synthesize various types of polymers by using suitable polymerisation techniques.
3. Capability to identify plastics materials by simple methods.

Equipment required:
glassware for reactions and spot tests, Ostwald/Ubbelhode viscometer, TGA, DSC

PA5201 PLASTICS TESTING TECHNOLOGY II

OBJECTIVE
- To develop knowledge of National & International standards for testing methods.
- To create the knowledge about the conditioning of samples and sample preparation techniques for testing various properties of plastics materials.
- To enable the students to learn about the evaluation of thermal, electrical, optical and mechanical properties of plastics materials.
- To create knowledge about testing of plastics products as per the standards.

UNIT I
Consideration of the importance of testing-Identification of plastics-Determination of necessary manufacturing conditions-Assessment of properties of finished products in relation to service requirements-Standard and specification-Application of national and international standards (BIS-
ASTM-ISO) for testing and their significance, Knowledge and exposure on Sectorial Testing Standards.
National and International standards-Test specimen preparation-Preconditioning and test atmosphere.

UNIT II

UNIT III

UNIT IV

UNIT V
Product testing-Pipe and fittings-film and sheets-container testing and FRP based products. Factors for designing tests for newer products Factors affecting the quality of materials and products Analysis of failure and its measurements Techniques of characterisation-Principles and application of DSC- TGA and FTIR Concepts of non-destructive testing

TOTAL : 45 PERIODS

OUTCOME
Upon completion of this course

- Ability to test the plastics materials for its chemical, mechanical, electrical, optical, thermal, and permanence properties as per the standard.
- Ability to identify the plastic materials by reverse engineering for some specified applications with the knowledge of testing.
- Ability to control the quality of plastics products by testing.

REFERENCES
4. Plastic Engineering Hand Book & D-5 By Society of Plastics Industry Inc Identification & Analysis of Plastics By Haslam& Others..
5. Simple Methods for Identification of Plastics By Brawn, R.B.Analysis of Plastics By Crompton, J.
OBJECTIVES:
- To impart knowledge of various types of composites and its advantages and needs.
- To make the student understand the various types of fiber materials and its applications for making Composites.
- To understand the knowledge of various resins materials used in processing of composites and the basic destructive and non-destructive testing of composites

UNIT I
Introduction to composite material – classification - advantages - polymer composites Thermosetting and thermoplastic matrix materials – Reinforcements-Types and Forms-particulate, flake, fibrous etc.,- coupling agents-Principles of composite reinforcement. Effect of reinforcement on composite properties.

UNIT II
Theory of composite materials - calculation of composite properties- mechanism of load transfer, minimum and critical fibre content, critical fibre length- Rule of mixtures – Halpin -Tsai - equation.

UNIT III
Compounding of Thermoplastics- Twin screw extrusion, compression moulding- compounding of polyolefins, polystyrene and styrene copolymers, engineering polymers, wood floor and natural fiber filled plastics, compounding lines, post compounding operations.

UNIT IV
FRP processing - important methods - hand layup, spray up, filament winding, compression moulding, injection moulding, resin, transfer moulding, reaction injection moulding, pultrusion, miscellaneous methods - machinery, operation, advantages and disadvantages.

UNIT V

TOTAL: 45 PERIODS

OUTCOME
- Will be conversant with knowledge of various types of composites and its advantages and needs.
- Will be able to know various types of fibers and matrix materials and their applications in making composite products.
- Will understand the knowledge of various processing operations for composites and the basic destructive and non-destructive testing of composites

REFERENCES
OBJECTIVES

- To impart knowledge on metal cutting and machine tools
- To develop the knowledge on advanced mould manufacturing processes
- To learn the basics of measuring instruments for inspection and quality control

UNIT I MATERIAL AND HEAT TREATMENT


UNIT II METAL CUTTING AND MACHINE TOOLS

Mechanism of metal cutting - Orthogonal & oblique cutting - Types of chips - Types of tool - Single point and multi point cutting tool -Nomenclature - Tool signature, Cutting tool materials, Tool life, Influencing factor of Tool, Cutting fluid.


UNIT III CNC MACHINE TOOLS

Introduction to CNC Machines and classification -Lathe, Milling, Electric Discharge machining (EDM) and Wire-Cut EDM - Working principle, operation and application; Manual Part programming, Dimensioning method and coordinate system, G-code, M- code, Cutter radius and length compensation, Types of cutting tools, Tool holding devices, work holding devices, speed, feed and Cycles; Computer Aided Part program – CAM packages; Advantages, disadvantages of CNC machine tools.
UNIT IV  MOULD FINISHING AND ASSEMBLY

Mould finishing: Various techniques – Polishing-types, procedure and polishing tools, - Chromium Plating - Nickel plating -Photo chemical etching - EDM Finishing and Electroforming.

Mould Assembly: Check list for mould assembly- Fitting and assembly of various mould elements- Core insert, Cavity insert, Sprue bush, Ejection system assembly- Blue matching and Die Spotting- Venting - Final inspection- Fitting of locating ring and carrier bar- Mould trial.

Introduction Mould Maintenance

UNIT V METROLOGY

Need for measurement – Dimensional and Form tolerances- Precision and accuracy - Errors in measurement, Working principle and applications of Measuring instruments – Steel rule and divider, Vernier caliper, micrometer, vernier height gauge, vernier depth gauge, Dial indicator, Slip / Pin gauges, Bevel protector, Sine bar, Squares, Optical profile protector, Tool maker microscope, Optical flat and CMM.

Application of Surface plate – V block - Angle plate - Straight edge - feeler gauge - radius gauge - pitch gauge.

TOTAL: 45 PERIODS

OUTCOMES

Upon completing this course, the students will have

- Ability to select the machining process to manufacture the mould.
- Ability to use suitable measuring instruments for inspection of mold
- Ability to apply knowledge of finishing process to have the required mould surface.

REFERENCES

4. HMT Production Technology, TMH (India), 1992

PA5204 BLENDING OF POLYMERS

OBJECTIVE

- To impart knowledge on selection, characterization& testing of blends and alloys
- To develop knowledge on properties & applications of polymer blends and alloys based on commodity plastics, engineering and speciality plastics

UNIT I

Introduction to polymer blends & alloys – Definitions and nomenclature – Criteria for making polymer blend –Selection of polymer for blend components –mechanism of mixing and dispersion,

**UNIT II**


**UNIT III**


**UNIT IV**


**UNIT V**


**OUTCOME**

The students will have an

- Ability to demonstrate knowledge and understanding in the blends of various polymers, its solubility parameter, compatibility and phase separation and rheology of polymer blends and alloys.
- Ability to prepare a new blend to meet the requirement economically and environmentally friendly.

**REFERENCES**


**OBJECTIVE**

- To learn about microprocessor controlled injection moulding machine, Blow moulding process, rotational moulding, thermoforming with different moulds and material.
To understand the possible defects, its causes and setting of process parameter.

EXPERIMENTS
1. Microprocessor controlled Injection moulding operation
2. Blow Moulding Automatic
3. Vacuum Forming
4. Rotational Moulding
5. Coating of Plastics
6. Welding & Sealing of Plastics
7. Screen Printing
8. Machine Maintenance
9. Mould Study
10. FRP – Hand layup process
11. Co-extrusion

TOTAL : 60 PERIODS

OUTCOME
• Ability to select the suitable process parameter.
• Ability to analyse cause for defects and trouble shoot it.

REFERENCES

LABORATORY REQUIREMENTS
1. Microprocessor controlled inj. moulding machine - 1 No.
2. Blow moulding machine (Automatic) - 1 No.
3. Vacuum forming machine - 1 No.
4. Rotational moulding machine - 1 No.
5. Plastics coating machine - 1 No.
6. Ultrasonic welding machine - 1 No.
7. Plastic sealing machine - 1 No.
8. Printing machine (on plastics) - 1 No.
10. Moulds maintenance kit - 2 Nos.
11. Moulds for plastic products - 1 No.
12. FRP hand layup kit - 1 No.

OBJECTIVE
• To learn the use of Computer Aided Design in mould designing.
• To analyse the flow behaviour of plastics materials while processing using mold flow software.

LIST OF EXPERIMENTS
I. Plastics Product Design using CAD
2D and 3D modelling of plastic components
II. Mold Design using CAD
a) Injection Mould design
Design calculations for No. of cavities, Selection of injection moulding machine, shot capacity, plasticizing rate, Clamping force and 2 D / 3 D Modelling for Two plate, Three Plate and split Moulds

b) Compression Mould Design
Design calculations for No. of cavities, Flash thickness allowances, Design of loading chamber, Bulk factor, Pressure pad, Heaters and 2 D / 3 D Modelling for Compression Mould.

c) Transfer Mould Design
Design calculations for Pot, Bulk factor, Heaters and 2 D / 3 D Modelling for Pot and Plunger transfer Moulds.

d) Blow Mould Design
Design calculations for Clamping force, pinch-off, Head die design, Parison dimensions and 2 D / 3 D Modelling for Blow Mould.

e) Extrusion Die Design
Design calculations and 2 D / 3 D Modelling for Extrusion Die

III. Mouldflow Analysis
- Modelling, Mesh Creation, Mesh Checking, Surface repair , Creating Feed system and cooling system.
- Analysis: Gate location, Molding window Fill, Flow, Cool, Pack, Warp, Shrinkage, Stress

TOTAL : 60 PERIODS

OUTCOMES
- Ability to design and develop the moulds using CAD/ CAM/CAE software.
- Ability to predict the flow behaviour of the materials in the designed mould.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Description</th>
<th>Qty.</th>
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<tbody>
<tr>
<td>1</td>
<td>Computer Systems</td>
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<tr>
<td>2</td>
<td>2 D &amp; 3D Modeling Software</td>
<td>30 Licenses</td>
</tr>
<tr>
<td>3</td>
<td>Flow Simulation software</td>
<td>30 Licenses</td>
</tr>
<tr>
<td>4</td>
<td>Printer</td>
<td>1 No.</td>
</tr>
</tbody>
</table>

REFERENCES
1. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.

PA5213 PLASTICS TESTING LABORATORY II

OBJECTIVE
- To train the students in testing of plastics for properties.
- To understand the various testing done on different plastics products.

LIST OF EXPERIMENTS
1. Compounding, Blending using Two Roll Mill and Specimen
2. Determinations of Carbon Black Content and Dispersion
3. Determination of environmental stress cracking resistance For olefins
4. Testing of HDPE/RPVC Pipes
5. Testing of Water Storage Tanks/Containers
6. Testing of Films/Sheets
7. Testing of HDPE/PP Woven Sacks/Tapes
8. Testing of Bottles/Vanaspati, Ghee, Milk Packing
9. Testing of Plastics Products for Determination of Mechanical Properties

OUTCOMES
At the end of this course,
- Ability to prepare specimens through compounding, two roll mill for testing of various properties of plastics materials.
- Ability to test the give plastics product as per the standard and apply the result to take a decision.

REFERENCES

EQUIPMENT / DEVICES REQUIRED

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Equipment</th>
<th>Quantity Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ribbon Blender</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Compounding Extruder</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Injection moulding machine</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Compression moulding machine</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Two roll mill</td>
<td>1</td>
</tr>
</tbody>
</table>

TOTAL: 60 PERIODS
The seminar power point presentation shall be fundamentals oriented and advanced topics in the appropriate branch of engineering with references of journal papers. Presentation is to be planned for duration of 15 minutes including a question answer session of five minutes. The marks will be awarded based on the presentation of the seminar.

**TOTAL: 30 PERIODS**

**PA5312**

**PROJECT WORK (PHASE I)**

**Project report:** To be prepared in proper format decided by the University. The report may include the aspects of the literature review. Members of a project group shall prepare and submit the report.

A comprehensive oral Viva-voce examination will be conducted to assess the student's, depth of understanding in the specified field of engineering and technology..etc.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination.

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**PA5311**

**SEMINAR**

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment/Kits</th>
<th>L T P C</th>
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</thead>
<tbody>
<tr>
<td>6</td>
<td>Contour cutter</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Carbon black content tester</td>
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</tr>
<tr>
<td>8</td>
<td>Environmental stress cracking resistance tester</td>
<td>1</td>
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</table>

**Mechanical and Product Testing**

<table>
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<th>No.</th>
<th>Equipment/Kits</th>
<th>L T P C</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Ribbon Blender</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Compounding Extruder</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Universal testing machine</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Tear strength tester</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Impact strength tester</td>
<td>1</td>
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<tr>
<td>14</td>
<td>Abrasion resistance tester</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Burst strength tester</td>
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<tr>
<td>16</td>
<td>Humidity chamber</td>
<td>1</td>
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<tr>
<td>17</td>
<td>Gas permeability tester</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Hydrostatic bursting pressure tester</td>
<td>1</td>
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<tr>
<td>19</td>
<td>Reversion tester</td>
<td>1</td>
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<tr>
<td>20</td>
<td>Falling Dart Impact Tester for films and Pipes</td>
<td>1</td>
</tr>
</tbody>
</table>

**Electrical and Optical Properties**

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment/Kits</th>
<th>L T P C</th>
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<tbody>
<tr>
<td>21</td>
<td>Volume and Surface resistivity</td>
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<tr>
<td>22</td>
<td>Dielectric strength</td>
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<tr>
<td>23</td>
<td>Arc Resistance</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>Haze meter</td>
<td>1</td>
</tr>
</tbody>
</table>

**Contour cutter**

**Carbon black content tester**

**Environmental stress cracking resistance tester**
Project report: To be prepared in proper format decided by the University. The report shall record all aspects of the work. Members of a project group shall prepare and submit the report.

A comprehensive oral Viva-voce examination will be conducted to assess the student's intellectual achievement, depth of understanding in the specified field of engineering and technology..etc.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination

PA5001 ADVANCED PLASTICS PROCESSING TECHNOLOGY

OBJECTIVES

- To understand the specialized injection moulding process viz., Co-injection moulding, Two-colour injection moulding process, Gas assisted Injection Moulding, Reaction Injection Moulding, Liquid injection moulding, structural foam moulding and to understand the effect of shrinkage, merit & demerits of the process
- To understand advanced blow moulding process & advanced Extrusion process.
- To expertise the student with sufficient background for selection of processing techniques.

UNIT I SPECIALIZED INJECTION MOULDING PROCESS - I

UNIT II SPECIALISED INJECTION MOULDING PROCESS – II
Multi-layer Moulding, Counter flow moulding, Liquid Injection Moulding processes. Structural foam moulding - Low pressure and high pressure processes - Merits &demerits.

UNIT III ADVANCED BLOW MOULDING - I

UNIT IV ADVANCED BLOW MOULDING – II

UNIT V ADVANCED EXTRUSION PROCESSES

TOTAL : 45 PERIODS

OUTCOMES

- Ability to select the advance processing technique as per the requirement.
REFERENCES
3. Engineered Materials Handbook, ASM International Handbook committee, USA
13. Schar, J., Press blowing option for tough to blow parts, SPE ANTEC April’87.

PA5002 PLASTICS PACKAGING TECHNOLOGY

OBJECTIVE
- To enable the students to understand the concepts of plastics materials used in packaging industries,
- To understand the machinery used in packaging field and testing equipments used for packaging product.

UNIT I
Introduction to Packaging – Functions of packaging – Major packaging materials viz. Polyolefins, Polystyrene, Polyvinylchloride, Polyesters, Polyamides (Nylons), Polycarbonate and Newer materials such as High Nitrile polymers, Polyethylene Naphthalate (PEN), Polyetherimide (PEI) and LCP – Properties and Applications in Packaging.

UNIT II
Adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet co extrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulk and heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion and injection blow moulding, foams, cushioning and distribution packaging.

UNIT III
Edible and bio-based food packaging materials, Edible film and coating, Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and Third bio-based packaging materials. Permeability of thermoplastic polymers, Multilayer films, Processing,
Deteriorative reaction in foods, Enzyme reactions, Chemical reactions, Physical change, Biological change, shelf life of foods, Factors controlling shelf life.

UNIT IV

UNIT V
Mechanical properties – Tensile properties, Impact properties, Tear strength, Burst strength, Stiffness, Crease or flex resistance, Co-efficient of friction, Blocking, Orientation and shrinkage. Optical Properties – Clarity, Haze and gloss Barrier Properties – Oxygen transmission, Water vapour transmission rate – Migration.

TOTAL: 45 PERIODS

OUTCOMES
Upon completing this course, the students

- Will gain the knowledge on the plastic packaging process and materials.
- Will familiarize in testing of plastic packaging
- Will attain the knowledge of thermoforming packaging

REFERENCES

PA5003 COATING SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES
- To know about the various components in a paint and functions of each component and their advantages.
- To learn the synthesis and mechanism of film formation of binders in surface coating,
- To understand the formulations of different types of paints.
- To know the methods of application of surface coatings and paints, evaluation of paints and their applications.

UNIT I INTRODUCTION TO PAINTS
Basic paint technology; drying oils, Polymer binders, Pigments, extenders and additives.

UNIT II FORMULATION AND PROPERTIES OF PAINTS
Essential concepts of paint formulation and paint properties : paint preparation (pigment dispersion), surface preparation and paint application, paint properties and their evaluation mechanism of film formation, factors affecting coating properties, methods used for film preparation and their properties; barrier properties and corrosion, mechanical properties, aging properties, rheological properties, adhesion properties and other related properties.
UNIT III  COATING SURFACES  9
Mathematics of paint formulation, formulations of coatings as finishes (automotive appliances, coil, can, marine, aircraft etc) and for various substrates (Steel, timber, masonry, plastics etc.)

UNIT IV  SPECIALTY COATINGS  9
State of the art technologies for radiation durable, nonpolluting, powder, high solids.

UNIT V  WATER BORNE COATINGS  9
A Fundamental Constituent of water-borne coatings, types of aqueous coatings systems, binders in water-borne coatings, additives in water-borne coatings, pigments and fillers, action of amines and auxiliary solvents in aqueous, manufacture of water-borne coatings

TOTAL: 45 PERIODS

OUTCOME
- Students learn about various components in paint formulations and different types of paints and surface coatings. They understand the mechanism of film formation and advantages and disadvantages of various binders in paint/surface coating. They also learn about various techniques for application of coatings and their reevaluation.

REFERENCES

PA5004  PLASTICS MOULD AND PRODUCT DESIGN  LT P C
3 0 0 3

OBJECTIVE
- To learn the design concepts for various mould elements.
- To learn the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould and Extrusion Dies.

UNIT I  PRODUCT DESIGN  9

UNIT II  INJECTION MOULD DESIGN  9
Introduction – Elements of Injection Mould - Factors considered for Mould Design - Shot Capacity- Plasticising Rate - Clamping Force- Injection Time – Cooling Time - Number of Cavities – Layout of Cavities.

UNIT III


UNIT IV

DESIGN OF COMPRESSION & TRANSFER MOULD


Transfer Mould Design: Introduction -Types – Design of Pot and Plunger - Calculations of Projected area, Transfer Pressure, clamping force - Design of Pressure pad and Feed system - Advantages, Disadvantages and Applications of Transfer Mould

UNIT V

DESIGN OF OTHER MOULDS & DIES

Blow Mould Design: Introduction - Types of blow moulds - Blow ratio - Parison design – Pinch off design - parting line - mould cooling - mould alignment.


Extrusion Die Design: Principles of extrusion - construction of die - die geometry - die swell - die land design - sizing die -Advantages, Disadvantages and Applications.

OUTCOMES

Upon completion of this course,

- The students will understand the basics of plastics mould design and also product design.
- They also acquire knowledge about various moulds for different processing techniques.

TEXTBOOKS

3. Injection Mould Design for Thermoplastic - By Pye, R.G.W.

REFERENCES

3. Fundamentals of plastics mould design – By Sanjay K Nayak, Pratap Chandra Padhi and Y. Hidayathullah
PA5005      CAD/CAM/CAE APPLICATIONS IN MOULD / TOOL DESIGN        LT P C  
            3 0 0 3

OBJECTIVES
To enable the students

- To provide an overview of how computers are being used in Design of Plastic Component, Manufacturing of Tool and Analysis of mould flow.
- To develop the knowledge of computer aided manufacturing.

UNIT I   COMPUTER GRAPHICS
         9
Fundamentals: Output primitives (Points, lines, curves, etc.,) - 2-D and 3D Transformations- Homogeneous Coordinates- Windowing, Viewing and clipping transformation- Introduction to curves- Analytical Curves- circle and conics- Synthetic Curves Bezier and B-spline curve. 
Graphics Standards: Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - Communication standards

UNIT II  COMPUTER AIDED DESIGN (CAD)
         9
Surface modelling: Bezier and B-Spline surface- Bi- linear surface- Boundary Representation- Sweep representation. 
Assembly Modelling: Assembly of parts, Tolerance analysis, Mass property calculations, and Interference Checking

UNIT III  COMPUTER AIDED MANUFACTURING (CAM)
         9
Introduction to NC machines, CNC machines, Direct Numerical Control (DNC), Advantages & Disadvantages, Working principle of CNC machines - Introduction to CAM software packages -G Codes & M Codes – Part programming for CNC Turning Center and CNC Machining Center.

UNIT IV  FINITE ELEMENT ANALYSIS (FEA)
         9
Introduction to Finite Element Analysis (FEA), Types of analysis - Procedure for finite element analysis -Finite Element Analysis packages, and its application; Analysis of One Dimensional Bar elements- Derivation of Shape function and Stiffness matrix and force vector – Assembly of matrix – Field problems.

UNIT V   MOLD FLOW ANALYSIS
         9
Introduction to Moldflow analysis- Design principles- Product design and Moldflow - Sequence of analysis- Moldflow concepts- Meshes used in Moldflow analysis- Types, Requirement- Geometry Creation- Importing Geometry; Shirkages and Warpage- injection molding and shrinkage, basic cause of warpage and shrinkages ; Moldflow design procedure- Analysis steps framework, Evaluate an Initial design, optimized the design; Part defects.
OUTCOME

- Upon completion of this course, the students will acquire the knowledge of computer aided design and manufacturing for moulds for plastics processing.
- Knowledge on various CNC machining processes used in Mould manufacturing.
- They also learn about various types of analysis involved in Mouldflow.

REFERENCES


PO5091 RESEARCH METHODOLOGY

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OBJECTIVES

- To gain insights into how scientific research is conducted.
- To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.
- To learn and understand the basic statistics involved in data presentation.
- To identify the influencing factor or determinants of research parameters.
- To test the significance, validity and reliability of the research results.
- To help in documentation of research results.

UNIT I INTRODUCTION TO RESEARCH METHODS


UNIT II DATA COLLECTION AND SAMPLING DESIGN

Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire- Survey and Experiments – Design of Survey and Experiments - Sampling Merits and Demerits - Control Observations - Procedures – Sampling Errors.

UNIT III STATISTICAL MODELING AND ANALYSIS, TIME SERIES ANALYSIS


UNIT IV POLYMER RESEARCH

Polymer synthesis–structure property relation—characterization—testing—principles and
UNIT V RESEARCH REPORTS
Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report

OUTCOMES
- Ability to critically evaluate current research and propose possible alternate directions for further work
- Ability to develop hypothesis and methodology for research
- Ability to comprehend and deal with complex research issues in order to communicate their scientific results clearly for peer review.

REFERENCES

PA5006 PLASTICS CHARACTERIZATION TECHNIQUES

OBJECTIVES
- To familiarise the student with the common methods used in the analytical characterization of polymers
- To provide the student with an understanding of the fundamental physics and chemistry used by these techniques
- To expertise the student with a sufficient background to select the appropriate method of characterization and solve a given problem

UNIT I MOLECULAR WEIGHT DETERMINATION
Importance of molecular weight-Molecular weight averages – calculation of different molecular weight averages- Molecular weight determination techniques-Absolute andrelative method- End group analysis, Colligative Properties - Ebulliometry, Membrane osmometry and Vapour phase osmometry, Light scattering techniques, Dilute Solution viscometry and Gel Permeation Chromatography.
UNIT II SPECTROSCOPIC CHARACTERIZATION

UNIT III MICROSCOPIC AND CHROMATOGRAPHIC CHARACTERIZATION
Light Microscopy - Scanning electron microscopy – introduction, design and operation of SEM, primary, secondary, back scattered electrons and X-rays, application to polymers. Transmission electron Microscopy- layout of the TEM, diffraction, resolution, contrast, application to polymers and scanning transmission electron microscopy. Gas chromatography and GC-MS - theory and instrumentation, analysis of residual monomer like VCM, Acetaldehyde, Acrylonitrile and Styrene content, additive analysis in Polymers by Gas Chromatography and GC-MS.

UNIT IV THERMAL CHARACTERIZATION
The basis of Thermal Analysis – First and second order transitions in polymers- melt and cold crystallisation- Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – principle, instrumentation and application to polymers-crystallisation kinetics Thermo-mechanical Analysis (TMA) – Dynamic Mechanical Thermal Analysis (DMA) and Dielectrical Thermal Analysis - Theory and principle, instrumentation, application to polymers. Thermo gravimetric Analysis (TGA) - principle, instrumentation and application to polymers, degradation kinetics.

UNIT V RHEOLOGICAL CHARACTERIZATION

OUTCOME
After completion of the course, the student able to
- Predict both qualitative and quantitative basis on the structure, properties and composition of a polymer
- Analyze and interpret the data taken by physical characterization methods (thermal analysis, microscopy, scattering, spectroscopy and mechanical methods)

REFERENCES
7. T.R. Crompton, Characterization of Polymers, volume 1 and 2, Smithers Rapra technology limited, 2008

PA5007 PHYSICS AND RHEOLOGY OF POLYMERS

OBJECTIVE

- To understand the conformational property of polymer chain using different models
- To study the chain conformation in polymer solution and melt based on thermodynamics
- To introduce fundamental flow properties and methods used to investigate the flow behaviour under stress
- To understand the flow behaviour in different processing methods

UNIT I MOLECULAR CONFORMATION AND CONFIGURATION


UNIT II ELASTICITY

Thermoelasticity - Thermodynamics of rubbers – Flory construction- entropic and energetic contributions to the elastic force in rubbers – unentangled rubber elasticity- Affine network model- Phantom network model-entangled rubber elasticity-Edwards tube model-Mooney-Rivlin model

UNIT III SOLUTION PROPERTIES

Polymer solutions-theta condition-Thermodynamic view of miscibility-upper critical solution temperature (UCST)- lower critical solution temperature (LCST)-Concentration regimes in polymer solutions Viscoplasticity- elastic deformation-irrecoverable deformation - models of viscoelasticity- Voigt-kelvin-Maxwell-Burger models- WLF equation-TTS curve- Boltzman super position principle- stress relaxation-creep and creep recovery-

UNIT IV FLOW BEHAVIOUR


UNIT V MELT RHEOLOGY AND RHEOMETRY

OUTCOMES
At the end of the course student able to
- Know the conformational change of polymer chains in solution and melt
- Understand and measure the basic flow properties of polymers
- Relate the polymer rheology to properties of polymeric materials and processing

REFERENCES

PA5008 POLYMER FOR ADVANCED APPLICATIONS  L T P C  3 0 0 3

OBJECTIVE
- To familiarize the students with a specific class of advanced polymers defined on the basis of their specific properties.
- To emphasize on the study of property correlation with various aspects and processing requirements for specialty polymers, engineering and specialty applications like high performance applications, biomedical, aerospace engineering, electronics and other areas.

UNIT I LIQUID CRYSTALLINE POLYMERS (LCPS)  9
Introduction, history, structural requirements, types of liquid crystalline (LC) phases, types of liquid crystalline polymers, anisotropic properties, characterization of LC phases (DSC, POM, XRD, NMR, FTIR, Dielectric etc.), LC blends and composites, LC elastomers, rheology of liquid crystalline polymers, applications of LC polymers- optical, high strength fibers, MEMS etc.

UNIT II CONDUCTING POLYMERS  9
Theory of conduction, semi-conductors and conducting polymers, band theory, requirements for polymer to work as conductor, types of conducting polymers - intrinsic and extrinsic, doping of polymeric systems, synthesis, processing and testing of conducting polymers, applications and recent advances – electroluminescence, corrosion inhibition, microelectronics, membranes, sensors, textiles, electro-chemomechanical devices, coating etc.

UNIT III HEAT AND FIRE RESISTANT POLYMERS  9
Combustion of polymeric materials and methods to reduce it, requirements for heat resistance, determination of heat resistance, synthesis, structure-property relationships, fire retardant fillers, applications of heat resistant polymers like polyamides, polymides and its derivatives, polyquinolines, polyquinoxalines, PBT, PBO, PBI, PPS, PPO, PEEK, chlorinated polymers, engineering plastic blends.
UNIT IV SMART AND MISCELLANEOUS POLYMERS

Introduction to smart polymers, temperature responsive polymers, pH responsive polymers, photo responsive polymers, magnetically responsive polymers, enzyme responsive polymers, shape memory polymers, hydrogels, self-healing polymers. Applications of smart polymers in various fields such as drug delivery, tissue engineering, medical devices, bioseparation, optical data storage, packaging and textiles etc.

Macromolecules as catalysts, information transmitting polymers, reactive polymers, magnetic polymers, luminescent polymers, ion conducting polymers, high performance fibers, dendritic polymers, inorganic polymers, ionic polymers, hydrogels.

UNIT V BIOPOLYMERS AND BIODEGRADABLE PLASTICS

Biopolymers - Study of biopolymers and their applications, like bioassays, biocatalysts, etc., need of biomaterials and biopolymers, biodegradation, overview of biodegradable polymers, degradation study, factor affecting biodegradability, classification – natural, synthetic, modified, starch based, PHAs, PLA, synthetic biodegradable polymers- PBS, PCL, PGA, etc., environmental impact, biomaterials and their 16 medical applications, control release theory, scaffold materials, orthopedic applications, rehabilitation aids, etc., ASTM methods of testing.

TOTAL: 45 PERIODS

OUTCOME

Upon completion of this course, the students

- Will familiarize about advance polymeric materials and its application.
- Will develop the knowledge in the mechanism of preparation of materials
- Will acquire the skill in assessing the biopolymer and bio-degradability of polymers

REFERENCE BOOKS

2. Additives in waterborne coatings, Gerry Davison, Bruce Lane, Royal society of Chemistry, 2003

PO5071 THERMOPLASTIC ELASTOMERS

OBJECTIVE

- To understand about the different methods of synthesising TPEs and advantages over thermoplastics and elastomers
- To provide a comprehensive overview of different TPEs based on polyolefin, vinyl, styrenic, urethane and polyamides
- To familiarise the student about structure, properties and applications of different TPEs
UNIT I    CLASSIFICATION OF THERMOPLASTIC ELASTOMERS 9

Introduction to Thermoplastic Elastomers (TPE) Polyolefin – based thermoplastic elastomers –
Block copolymer, Random Block polymers, Graft copolymers, Polyolefin blend TPE’s preparation,
Properties, processing and applications.

UNIT II THERMOPLASTIC ELASTOMERS FROM CONVENTIONAL POLYMERS 9

Polyvinylchloride based Thermoplastic Elastomers – PVC/Nitrile Rubber blends,
PVC/Polyurethane blends. Styrenic Thermoplastic Elastomers – Manufacture, Properties
Applications.

UNIT III    POLYURETHANE ELASTOMER 9

Thermoplastic Polyurethane Elastomer – Raw materials, Synthesis, Properties, Processing,
Blends and Applications.

UNIT IV    POLYAMIDE AND POLYETHER BASED ELASTOMER 9

Polyamides based Thermoplastic Elastomers – Polyamide thermoplastic elastomers, Preparation,
properties, and applications. Thermoplastic Polyether ester Elastomers – Synthesis, Properties
and applications.

UNIT V    THERMOPLASTIC ELASTOMER FROM BLENDS 9

Introduction - Preparation of Elastomer – Plastic blends by dynamic vulcanization, properties and
applications. Ionomeric Thermoplastic Elastomers: Synthesis, Properties, and applications of
ionomeric elastomers

TOTAL : 45 PERIODS

OUTCOME
At the end of the course, the student should be able to

- differentiate the unique characteristics of different TPEs compared with thermoplastics and
  elastomers
- be able to select the suitable TPE for the application
- be able to Correlate the structure and properties of different TPEs

REFERENCES

1. Anil K. Bhowmick, Howard L. Stephens, Hand Book of Elastomers New Developments and
2. Benjamin M. Walker, Hand Book of Thermoplastic Elastomers, Van Mostrand Reinhold
   Company, New York, 1979
4. S.K. De, Anil K. Bhowmick, Thermoplastic Elastomers from Rubber – Plastic Blends, Ellis

PO5072    POLYMER NANOCOMPOSITES  L T P C
          3 0 0 3

OBJECTIVES

- To gain an understanding of materials commonly used for nano-modification such as
  nanoclays, carbon nanotubes, etc.
• To study different manufacturing techniques of dispersion of nano particles such as sonication, high shear mixing, centrifugal mixer, twin-screw extrusion.
• To study different manufacturing techniques to produce real-life components
• To understand characterization techniques of these materials using scattering, spectroscopic and microscopic techniques

UNIT I

Definition of nanocomposite, nanofillers, classification of nanofillers, carbon and noncarbon based nanofillers- synthesis and properties of fillers.

UNIT II

Properties of various polymer nanocomposites: Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing- Polyamide Matrices, Polyimide Matrices, Polypropylene and Polyethylene Matrices, Liquid-Crystal Matrices, Epoxy and Polyurethane Matrices, Rubber Matrices.

UNIT III

Synthesis of Nanocomposite: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing Ceramic/Polymer Composites, In-Situ Particle Processing Metal/Polymer Nanocomposites, Modification of Interfaces, Modification of Nanotubes, Modification of Nanoparticles. Surface treatment, Composites manufacturing techniques.

UNIT IV

Characterization of Nanocomposites: Particle Size Analysis, Glass Transition and Relaxation, X-ray Diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy, Small-Angle X-Ray Scattering (SAXS), Cone Calorimetry (CC) and Mass Loss Calorimetry (MLC).


UNIT V

Nanocomposites containing functionalized nanoparticles: Organic and polymer materials for electronics devices such as LED, Photo-voltaics etc.,- Polymer Nanocomposites for Bio-medical application, Photo-oxidation of polymers, Nanoparticles approaches to enhance the lifetime of polymers

OUTCOMES

At the end of the course, the student should be able to

• The student will Know different characterization and testing techniques and interpretation of results
• The student will have a knowledge about different structures and properties of nanocomposites

TOTAL: 45 PERIODS
• The student will have an idea about preparation technologies and applications of nanocomposites

REFERENCES

2. L.A. Utracki “ Clay-Containing Polymeric Nanocomposites” Rapra Technology Limited, 2004
3. Luigi Nicolis & Gianfranco Carotenuto “Metal -Polymers Nanocomposites” A John Wiley & Sons, Inc Publication 2005
5. Y.C. Ke & P. Stroeve “ Polymer-Layered Silicate and Silica Nanocomposites- Elsevier, 2005

PA5009 SECONDARY PROCESSING TECHNIQUES

OBJECTIVES:

• To know about the different processing methods like calendaring, thermoforming, and rotomoulding.
• To gain knowledge about the processing of FRP laminates.
• To understand the various machining and joining method for plastics products.

UNIT I CALENDERING, THERMOFORMING AND ROTOMOULDING

Calendering: Introduction – type of calenders – roll configuration – Definition of terms such as calender bank – calendering process – process variable and application.

UNIT II FRP LAMINATES

Introduction, FRP processing methods – contact moulding – hand lay up, spray up method– vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion,matched die moulding – Laminates, definition of terms – high, pressure laminating process, types of machinery, impregnation systems – decorative and industrial laminates, continuous high pressure laminating process, application.

UNIT III CELLULAR PLASTICS

Introduction – process to create foam in resins – mechanical foaming, chemical foaming, physical foaming – processes to shape and solidify foams – low pressure foam moulding, high pressure foam moulding, RIM extrusion foaming, casting foams, steam chest moulding structural foam moulding – applications.

UNIT IV MACHINING& JOINING OF PLASTICS

Introduction – Importance of machining – methods viz. cutting, drilling, blending, filling, etc. Joining – principles – cohesion principle, adhesion principle – solvent cementing, Dop cementing, welding
of plastics – viz. high frequency welding thermal sealing, spin welding, vibration welding, hot plate welding, ultrasonic welding, Adhesive bonding – examples: Mechanical fasteners.

**Other Secondary Processes:** Printing, painting, Hot stamping, In mould decoration, Electroplating and vacuum metallising.

**UNIT V CASTING PROCESSES AND ROTATIONAL MOULDING**


**Coating Processes:** Roller coating, powder coating, fluidised bed coating, electrostatic spray coating, processes and applications.

**TOTAL:** 45 PERIODS

**OUTCOME:**
- Ability to select a specific processing technique as per the requirement.
- Ability to choose a machining and joining method of plastic products.

**REFERENCES**
2. Basic Principle of Rotational Molding - By Bruins.
4. Basic Principle of Thermoforming - By Brycle, D.M
5. Compression Moulding - By Iyesew, A.I.
8. Injection Moulding - By Athalye, A.S.
10. Innovation in Polymer Processing - By Stevenson.
13. Plastics Injection Moulding - By Brycle, D.M.
17. Thermoforming - By James & Throne.

**PA5010 ADDITIVE MANUFACTURING IN PLASTICS PRODUCTS**

**OBJECTIVE**
- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology for plastics product
- To learn the fundamentals process of additive manufacturing process.

**UNIT I**

Introduction to Additive Manufacturing (AM)- AM evolution, Distinction between AM & CNC machining, Advantages of AM; AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing; Classification of AM processes: Liquid polymer system, molten material systems, discrete particle system, solid sheet system.
UNIT II
Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, Advantages, limitations and applications; Solid Ground Curing (SGC): Principle, process, Advantages, limitation, and applications; Fused deposition Modeling (FDM): Principle, details of processes Advantages, limitation, and applications; Laminated Object Manufacturing (LOM): Principles, details of processes, products, materials, advantages, limitations and applications;

UNIT III

UNIT IV
Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc;

UNIT V
AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling ( Direct and Indirect method), new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries; Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

TOTAL: 45 PERIODS

OUTCOMES
Upon completing this course, the students will have an

- Ability to choose a suitable Additive Manufacturing (AM) method.
- Ability to face the research challenges associated with AM and its data processing tools

REFERENCES
OBJECTIVES

- To learn about various types of biopolymers produced from starch and microbes.
- To know about the various bio-based feed stocks for biopolymers.
- To learn about different types of natural fibers and their surface treatments.
- To learn about different types of thermoset and thermoplastic bio composites and their characterization.

UNIT I  BIOPOLYMERS  9
Recent Development in the Bio-Polymer Industry - starch based materials, Plant Produced Polymers, Microbiologically produced polymers, Biologically Based resins, Adhesives, and coatings, continuing research and development on Bio-polymers.

UNIT II  NATURAL FIBERS  9
Bastfibers (Jute, Flax, Ramie,hemp, Kenaf)-Seed fibers (Cotton, Coir and Kapok)-Leaf fibers (Sisal,Pineapple and Abaca) -Grass and reed fibers (rice, corn and wheat)-Wood fibers-Different surface treatments-alkali-silane-isocyanate – benzoylation-acrylation, etc

UNIT III  THERMOSET BIOCOMPOSITES  9

UNIT IV  THERMOPLASTIC BIOCOMPOSITES  9

UNIT V  CHARACTERISATION OF BIOCOMPOSITES  9
FTIR-Fiber–resin surface tension and interfacial adhesion-Viscoelastic properties-Rheological properties-Mechanical-Thermal-Morphology-Flammability.

TOTAL : 45 PERIODS

OUTCOME

- Students understand production of bio-plastics from bio-based feed stocks.
- Learn about various natural fibers.
- Understand the different types of thermoset and thermoplastic bio composites and their characterization.

REFERENCES

OBJECTIVES
- To emphasize the fundamentals and importance of plastics recycling.
- To impart the knowledge on various sorting and separation techniques.
- To highlight recycling procedures for commodity and engineering plastics.
- To familiarize rubber recycling procedures.

UNIT I  FUNDAMENTALS OF PLASTICS RECYCLING  9

UNIT II  RECYCLING OPERATIONS  9

UNIT III  RECYCLING MATERIALS- I  9

UNIT IV  RECYCLING MATERIALS- II  9

UNIT V  RUBBER RECYCLING  9
OUTCOMES

Students will able to:

- Apply the principles of various methods of recycling and to relate the methods to various polymeric materials.
- Understand the need for recycling and classification of recycling methods.
- Sort and separate mixed plastics.
- Recycle domestic and engineering thermoplastics.
- Acquire the knowledge of various techniques for rubber recycling

REFERENCES


PA5012 ADVANCED MOULD MANUFACTURING TECHNOLOGY

OBJECTIVES:

- To impart knowledge on various Cutting Tools and CNC Machines
- To develop the knowledge on elements of the mould and manufacturing processes with CAD/CAM/CAE.
- To learn the application of additive manufacturing in mould development
- To acquire skills in advanced measuring instruments for inspection of mold

UNITI CNC MACHINING CENTERS


UNITII CNC TURNING CENTERS

UNIT III  
CNC DIESEL KING EDM AND WIRE EDM  

UNIT IV  RAPID TOOLING
Introduction to Additive manufacturing-Difference between rapid tooling & conventional tooling – Development of mould elements with RP-conformal cooling of mould elements—silicon moulds for Vacuum Casting-Epoxy Tooling System-Parts in Minutes—Composite tooling board—Applications, advantages and disadvantages of rapid tooling.

UNIT V  ADVANCES IN METROLOGY

TOTAL : 45 PERIODS

OUTCOMES:
Upon completing this course, the students
- Ability to apply the knowledge in CNC Machine Tools for mould manufacturing
- Ability to select 3 D printing and rapid tooling techniques.
- Ability to use advanced measuring equipment for inspection of mold

REFERENCES
1. HMT Production Technology, TMH (India),1992

PA5072  TOTAL QUALITY MANAGEMENT  L T P C
3 0 0 3

OBJECTIVES
- To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management

UNIT II INTRODUCTION
UNIT II TQM PRINCIPLES
Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal – Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES-I

UNIT IV TQM TOOLS AND TECHNIQUES-II

UNIT V QUALITY SYSTEMS

TOTAL: 45 PERIODS

OUTCOMES
• To under the various principles, practices of TQM to achieve quality
• To learn the various statistical approaches for quality control.
• To understand the TQM tools for continuous process improvement. To learn the importance of ISO and Quality systems

REFERENCES

PA5013 BIO-MEDICAL PLASTICS

OBJECTIVES
• To learn about various types of biopolymers produced from starch and microbes. To understand various natural and synthetic polymers used for biomedical applications.
• To learn about the plastics that are used as implants in cardiovascular, dental, ophthalmology, and other artificial organs.
• To be familiarized with evaluation methods of biomedical polymers and their interaction with human system in in-vivo and in-vitro environments.
UNIT I BIOPOLYMERS 9
Recent Development in the Bio-Polymer Industry - starch based materials, Plant Produced Polymers, Microbially produced polymers, Biologically-Based resins, Adhesives, and coatings, continuing research and development on Bio-polymers.

UNIT II SYNTHETIC AND NATURAL BIOMATERIALS 9
Polyolefin’s, Polyamides, Acrylic Polymers, Fluorocarbons, Polyesters, Engineering Plastics. Collagen, Polysaccharides, Proteins, etc.

UNIT III MEDICAL APPLICATIONS OF PLASTICS 9
Cardiovascular implants, Dental Implants, Role of plastics in Ophthalmology, Hydro gels, Drug Delivery systems, Sutures, Burn Dressings and Artificial skin, Hernia Mesh, Adhesives and Sealants, Artificial organs and devices, Blood bags, Condoms, etc.

UNIT IV POLYMER INTERACTIONS AND BIO DEGRADATION 9
Interaction with blood and blood compatibility, chemical and biochemical degradation of polymers, Tissue engineering and polymers.

UNIT V TESTING AND EVALUATION 9
in-vitro/vivo; Standards in product development and regulations; Ethical and sociological issues.

TOTAL: 45 PERIODS

OUTCOME
• Students understand production of bio-plastics from bio-based feed stocks. They learn about various plastics that are used for biomedical applications such as cardiovascular, dental, ophthalmology, and other artificial organs. Students also understand the methods and standards used for the evaluation of biomedical polymers.

REFERENCES:

PO5073 INTELLECTUAL PROPERTY RIGHTS (IPR) AND COPY RIGHT LAWS L T P C 3 0 0 3

OBJECTIVES
• To know about the intellectual properties, patents, trade marks and design rights
• To understand the procedure for applying patent documentation
• To get information on the industrial design and its projection
• To learn about the procedure for commercialization of intellectual properties

UNIT I 9
UNIT II 9

UNIT III 9

UNIT IV 9

UNIT V 9
Case Studies on – Patents (Basmati rice, turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

TOTAL: 45 PERIODS

OUTCOMES
On completion of this paper the student will
- Able to understand the laws and regulation governing the patents, trade marks and copyrights
- Able to know about the procedure for applying patent and copy rights
- Understand the basics of industrial design
- Have detailed knowledge of commercialization of patents and trademarks

REFERENCES

PA5014 INDUSTRIAL ECONOMICS AND COSTING

OBJECTIVES
- To develop the Knowledge about fundamentals of costing.
- To learn about the methods of materials control and pricing.
- To learn about the income tax rules.

UNIT I FUNDAMENTAL PRINCIPLES OF COST ACCOUNTING 9
UNIT II  PURCHASE & STORES ORGANIZATION  9
Purchase of materials – Procedure for purchases – Levels of materials – Economic ordering quantity. Store keeper and his functions – Bincard; Priced Stores Ledger – Perpetual Inventory System – ABC Method of stores control – Pricing of material issues (FIFO, LIFO, Average price, etc.).

UNIT III  LABOUR COSTING  9
Methods of recording attendance – Methods of remuneration – Time rate, Differential timerate, payment by results – Different Incentive schemes (Taylors differential, Merrick, Gantt Task Bonus, Emerson & Halsey plan).

UNIT IV  BUDGETARY CONTROL & MARGINAL COSTING  9

UNIT V  TAX RULES & REGULATIONS  9
Brief about Income tax Rules, Customs, Excise Rules, Sales Tax & its application in industry.

TOTAL : 45 PERIODS

OUTCOME

1. Ability to understand the costing of a product.
2. Ability to fix materials price, labours incentives.
3. Ability to follow tax rules and regulation.

REFERENCES