PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- PEO1: Graduates will be technically adept in Polymer Science & Engineering and acquire up-to-date knowledge and skills for professional success.
- PEO2: Graduates will exhibit appropriate interpersonal skills as demonstrated by effectively working on teams and effectively communicating in the workplace.
- PEO3: Graduates will exhibit a professional work ethic including an interest in personal and professional growth.
- PEO4: Graduates will be aware of how their professional role will impact the global community.

PROGRAMME OUTCOMES (PO)

A graduate of this major should be able to:

a. **Engineering Knowledge**: Select and apply the knowledge, techniques, skills, and modern tools of polymer Science and engineering to broadly defined polymer engineering activities.

b. **Problem Analysis**: Select and apply knowledge of mathematics, science, engineering, and technology to polymer science and engineering problems that require the application of principles and applied procedures or methodologies.

c. **Design/development of solutions**: conduct standard tests and measurements; conduct, analyze, and interpret experiments; and apply experimental results to improve processes.

d. **Conduct investigations of complex Problems**: design systems, components, or processes for broadly defined polymer science and engineering problems.

e. **Modern Tool Usage**: select and apply appropriate techniques, resources and modern polymer science and engineering tools

f. **The Engineer and Society**: understand the need for and engage in self-directed continuing professional development.

g. **Environment and Sustainability**: understand the impact of polymer science and engineering solutions in a societal and global context

h. **Ethics**: demonstrate an understanding of and a commitment to professional and ethical responsibilities, including a respect for diversity

i. **Individual and team work**: function effectively as a member or leader on a technical team.

j. **Communication**: communicate effectively regarding broadly defined polymer science and engineering activities..

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

l. **Life-long learning**: exhibit a commitment to quality, timeliness, and continuous improvement.
PROGRAMME SPECIFIC OUTCOMES (PSO)

m. **Research**: To apply basic principles of polymer science and engineering in various inter-discipline fields to engage various levels of research activity

n. **Placement and Entrepreneur**: Learn future technologies through acquired foundation skills and knowledge and employ them in industry and business environments

### PEO/PO MAPPING

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

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TOTAL CREDITS: 70

PROFESSIONAL ELECTIVES (PE)

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OBJECTIVE

- To make the student to acquire knowledge in fundamentals of polymers, bio and inorganic polymers.
- To impart knowledge in chain polymerization, Step growth polymerizations and copolymerization.
- To provide exposure to the students about Molecular weight, solubility and fractionation of polymers.

UNIT I  FUNDAMENTALS OF POLYMERS  9


UNIT II  BIO AND INORGANIC POLYMERS  9


UNIT III  CHAIN POLYMERIZATION  9

Kinetics and mechanism of free radical, cationic, anionic and coordination polymerization –Ziegler Natta catalysts-monometallic mechanism- stereo regular polymerization – chain transfer reaction and constant – living polymers – Alfin catalysts – initiators - new polymerization concepts and techniques like RAFT, click polymerization, green polymerization concepts

UNIT IV  STEP GROWTH POLYMERIZATIONS AND COPOLYMERIZATION  9


UNIT V  MOLECULAR WEIGHT, SOLUBILITY OF POLYMERS  9


TOTAL : 45 PERIODS

OUTCOME

- Will be aware of preparation and properties of polymers as related to the arrangement of chains in them.
- Will understand the utility of bio and inorganic polymers
- Will appreciate the complexities arising out of polydispersity in polymers
REFERENCES


PO5102 POLYMER PROCESSING TECHNOLOGY

OBJECTIVE

- To impart knowledge on mixing devices, extrusion moulding.
- To know the importance of Injection moulding and special moulding techniques.
- To understand the basic concepts in mould design

UNIT I MIXING DEVICES

Additives and Mixing process, different types of mixing devices - twin drum tumblers, ribbon blenders, Z-blade Mixer, high speed mixer, ball mill, two roll mill, Banbury mixer, internal mixing and screw mixing – twin screw compounding machines-differences between mixing conditions for rubbers and plastics

UNIT II CALENDERING AND EXTRUSION

Processing methods based on extruder (granule production, profile production, film blowing, blow moulding, extrusion stretch blow moulding) – extrusion coating process (sheet coating and wire covering).-rubber extrusion-hot feed and cold feed extrusion of rubber-calendaring of rubber compounds and PVC pastes -equipment and processes

UNIT III INJECTION MOULDING

Injection moulding machines and its components - moulds, multi cavity moulds, mould clamping devices, mould clamping force, injection blow moulding, reaction injection moulding.

UNIT IV OTHER MOULDING TECHNIQUES

Thermoforming – vacuum forming, Pressure forming and matched mould forming – Rotation moulding - Compression moulding- Transfer moulding

UNIT V BASIC CONCEPTS IN MOULD DESIGN

Types of moulds – Feed system -ejector system – ejection techniques – mould cooling – CAD / CAM applications

TOTAL: 45 PERIODS
OUTCOME

- Will be aware of different mixing devices and extrusion of rubbers and plastics.
- Will be able to methodically discuss injection and other moulding techniques.
- Will understand the basic concepts in mould design

REFERENCES


PO5103 THERMOPLASTIC MATERIALS

OBJECTIVE:

- To enable the students to understand the methods of preparation, properties and applications of thermoplastic materials covering i) commodity plastics ii) engineering plastics and high performance plastics.

UNIT I

Preparation, - Properties and applications of polyethylene - LDPE - LLDPE - HDPE, - Crosslinked polyethylene- Chlorinated polyethylene -Polypropylene - Homopolymers - Copolymers.

UNIT II

Preparation, - Properties and applications of poly(vinyl chloride) - Poly (vinylidene chloride)- Poly(vinyl alcohol) - Poly(vinyl acetate)- Chlorinated poly(vinyl chloride)- Plastisols, Poly vinylpyrroliidine, Polystyrene, HIPS, EPS.

UNIT III

Preparation - properties and applications of Acrylates - Poly (methyl methacrylate)- Polyacrylonitrile. Polyethylene terephthalate - Polybutylene terephthalate - Polyacetals and copolymers – Polycarbonates.

UNIT IV

Preparation, - Properties and applications of Fluoro polymers - Polytetrafluoroethylene, Polychlorotrifuoroethylene, Thermoplastic polyurethanes, poly -caprolactone and copolymers.
UNIT V

Preparation, properties and applications of High performance Thermoplastic materials PPS, PO, Polysulphone, Polyether Sulphone, PEEK, Polyimide.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will be familiar with manufacturing process of plastic raw polymers-especially commodity and engineering plastics
- Will acquire skills in selecting polymeric materials for specific applications
- Will have basic knowledge about high performance thermoplastics

REFERENCES:


PO5104 POLYMER ADDITIVES AND COMPOUNDING L T P C

OBJECTIVES

- To enable students know about various additives like Lubricants, Fillers, Fibres, flame retardants, colorants anti oxidants, UV-stabilizers, plasticizers, anti blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- To make them understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- To enable them 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 - Antioxidants-Stabilizers (Heat & UV)-carbon black-its types, manufacture and characteristics- mechanism of reinforcement of a rubber, non black fillers in rubbers

UNIT II ADDITIVES

UNIT III ADDITIVES FOR CURING OF RUBBERS
Vulcanisation - its importance and effect on rubber properties - vulcanising agents - accelerators, activators, PVI, non sulphur vulcanisation – vulcanisation techniques other than moulding like autoclave curing, microwave curing

UNIT IV MECHANISM OF MIXING
mechanism of mixing and dispersion, mixing of solid-solid, liquid-liquid and liquids-solids, dispersive mixing, distributive mixing, mixing entropic measures, mixing indices, scale of segregation and intensity of segregation,

UNIT V COMPOUNDING TECHNIQUES
Selection of Polymers and Compounding ingredients - Methods of incorporation of additives into Polymer materials, Compounding of PVC, PE and PP, morphology of filler, compatibilizers - mechanism and theory, filler surface modification and interfacial agents,

TOTAL: 45 PERIODS

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

- Will understand about various additives for rubbers and plastics – their needs, their functions and the mechanisms by which they act
- Will understand various compounding techniques used for making different grades of Plastics compounds

REFERENCES

PO5111 POLYMER SCIENCE LABORATORY

OBJECTIVES
- To make the student conversant with polymer synthesis, and appreciate the kinetics of polymerization.
- To enable students understand the methods for determination of molecular weight.
- To make them know the importance of fractionation of polymers.
Experiments on synthesis involving polymerization reactions like

1) Bulk polymerization
2) Emulsion polymerization
3) Suspension polymerization
4) Solution polymerization
5) Condensation/interfacial polymerization
6) Determination or reactive ratio for copolymerisation of styrene with MMA
7) TGA, DSC, IR
8) X-ray diffraction studies
9) Molecular weight and its distribution using viscometry, end group analysis, GPC, osmometry
10) Fractionation of polymers

**TOTAL: 60 PERIODS**

**OUTCOME**

- Will gain hands on experience on a few polymerization reactions.
- Will be able to methodically discuss the fractionation of polymers.
- Will develop capacity to characterize polymers using IR and thermal analysis.

**REFERENCES**


**Equipment needed:**

glassware for reactions, GPC, osmometer, Ostwald or Ubbelhode viscometer, DSC, TGA

**PO5112**

**POLYMER PROCESSING LABORATORY**

**OBJECTIVE**

- To enable students to get hands on experience on the processing of polymers
- To make the students understand the basic concepts of Identification, characterization, flammability and analytical testing of polymers.
LIST OF EXPERIMENTS

1. Preparation of Blow moulded products
2. Compression moulding of thermoset resin
3. Injection moulding of thermoplastics – Hand, semiautomatic and Fully automatic
4. Extrusion of thermoplastics
5. Compounding of plastics
6. Preparation of FRP laminates
7. Recycling of plastics – Scrap grinder
8. Casting of polymer films
9. Mixing of rubber compounds
10. Compression moulding of rubber compounds
11. Preparation of dry rubber products
   (i) Play ball (ii) Hawaii sheet (iii) M. C sheet (iv) Bottle Caps
12. Preparation of dispersions for compounding of latex
13. Preparation of latex products
   (i) Hand Gloves (ii) Balloon (iii) Rubber band (iv) Elastic Thread
(Any Eight experiments)

TOTAL: 60 PERIODS

OUTCOMES

- Will gain practical knowledge in Blow molding, compression molding, Injection molding of Extrusion of polymers
- Will gain knowledge in mixing of plastics and rubbers
- Will gain knowledge in manufacture of a few rubber and plastics products

Equipment required:
Blow moulding machine, Injection moulding machine, extruder, 2 roll mill, rubber curing presses, latex formers, scrap grinder

PO5201 CHARACTERIZATION AND TESTING OF POLYMERS

OBJECTIVE

- To impart knowledge on characterization tests, thermal and electrical properties.
- To enable the student learn about mechanical properties and flammability, optical properties, weathering and analytical tests.
- To provide exposure about testing and standards organizations.
UNIT I  CHARACTERIZATION TESTS  9

Basic principle of TGA, DTA, DSC, TMA, XRD, SEM, TEM, IR

UNIT II  THERMAL AND ELECTRICAL PROPERTIES  9

Heat deflection temperature, Vicat softening temperature, thermal conductivity thermal expansion, brittleness temperature – dielectric strength dielectric constant, dissipation factor, arc resistance, surface and volume resistance.

UNIT III  MECHANICAL PROPERTIES AND FLAMMABILITY  9

Tensile tests, compressive properties, impact properties, flexural strength, abrasion resistance hardness tests, shear strength – ignition properties, oxygen index

UNIT IV  OPTICAL PROPERTIES AND ANALYTICAL TESTS  9

Refractive index, haze, gloss, density, water absorption, moisture analysis, sieve analysis, apparent density, melting point

UNIT V  CHEMICAL, WEATHERING PROPERTIES AND TESTING ORGANIZATIONS  9

Weathering properties: Accelerated weathering test - Outdoor weathering test - Chemical properties: Immersion test - Stain resistance test - Solvent stress cracking resistance - Environmental Stress Cracking Resistance (ESCR) - ASTM, ANSI, UL, SPI and SPE.

TOTAL: 45 PERIODS

OUTCOME

• Will be aware of characterization tests, thermal and electrical properties.
• Will be able to appreciate optical properties and analytical tests.
• Will get an idea about testing and standards organizations.

REFERENCES

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 AND ADDITIVES OF COMPOSITES  9

Introduction – Advantages, Characteristics, of composites – Classification – particulate, fibrous, laminated, and hybrid composites, Additives for Composites - Catalysts - Accelerators - Coupling Agents - Fillers - Toughening Agents

UNIT II  MATRIX MATERIALS  9

Classification -Matrix Resins - Unsaturated Polyester - Vinyl Ester - Epoxy- Phenol Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde Resin - Properties and Applications

UNIT III  REINFORCEMENT MATERIALS  9

Fibre Reinforcements - Glass – Types - CSM – Surface Mats - Performs - Woven and Non Woven Fabrics - Carbon - Aramid Fibre - Boron Fibres - Natural Fibres – Cellulose

UNIT IV  PROCESSING OF COMPOSITES  9

DMC, SMC and Prepregs - Hand and Spray Layup - RTM - Bag - Autoclave - Centrifugal and Compression Molding Processes - Filament Winding - Pultrusion Sandwich Construction

UNIT V  TESTING AND APPLICATION OF COMPOSITES  9

Testing of Composites - Tensile, Impact, Compression and Flexural Strength- Non Destructive testing for Composites - Application of FRP Products

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

6. Polymer matrix nanocomposites, processing, manufacturing, and application: An overview,

PO5203 POLYMER PRODUCTS AND MOLD AND DIE DESIGN L T P C
3 0 0 3

OBJECTIVES
- To impart the knowledge on design factor involved in a polymer product manufacture.
- To understand the behavior of polymer product
- To impart the knowledge on design of mold and die for polymer products.

UNIT I
Introduction to structure and physical properties of polymers, stress - strain behaviour of polymers, effect of fillers on properties of polymers, stress analysis of polymers, structural design of beams, plates and other structural members

UNIT II
Design procedure for plastic parts- Basic Principles-Shrinkage-Flash lines- suggested Wall thickness-Draft-Tolerance-Moulded holes-threads-radius- moulded hinges-integral hinge-snap fits - product design thumb rules - case studies

UNIT III
Gear Design materials strength and durability, moulded vs cut plastics gear inspection assembly and operation. Bearings: Self lubricated plastic materials rubber bearing, type of bearings, designers check list. Elastomeric ring seals - basic configurations, design method, design consideration static and dynamic seals.,

UNIT IV

UNIT V
Types of compression moulding process-Determination of number of cavities-design of mould cavity, design of loading chamber-Transfer mould design- Extrusion die design-Construction features of an extruder, solid die-wire and cable die- Pipe die.

TOTAL: 45 PERIODS

OUTCOME
By the end of this course, students will be able to
- Demonstrate the ability to design rubber and plastics products
• Analyze design data for different polymer products
• Understand the principles of mould and die design for plastics products

REFERENCES
1. Edward Miller, “Plastics Products Design Hand Book”, Marcel Dekker,

PO5204 RUBBER TECHNOLOGY L T P C 3 0 0 3

OBJECTIVE
• To acquire knowledge in the Fundamentals of Rubbers and various Rubbery polymers.
• To know about the Processing of Rubber and Manufacture of tyres and Tubes.
• To impart knowledge on rubbers used in Belting, hoses and Footwear.

UNIT I  FUNDAMENTALS OF RUBBER
Criteria for a polymer to behave as a rubber – structure vsTg, chemical, mechanical and electrical properties - ozone attack on rubbers– protection against oxidation - antioxidants – network bound antioxidants, vulcanization – mechanism of sulphur cure-effect of crosslink density on properties – role of accelerators, activators – non–sulphur vulcanization systems.

UNIT II  GENERAL PURPOSE RUBBERS
Preparation, properties and uses of : Natural rubber, SBR, BR, IR

UNIT III  SPECIAL PURPOSE RUBBERS
Heat resistant rubbers –polysisobutylene, butyl and EPDM rubbers –solvent/oil resistant rubbers – nitrile, neoprene and chloroprene rubbers, EMA ,ACM, EVA – hypalon and chlorinated PE – high performance, specialty and modified rubbers – fluorine containing and silicone rubbers, polyurethanes, and thermoplastic elastomers

UNIT IV  MANUFACTURE OF TYRE AND TUBES
Tyres – functions, requirements – basic design reinforcing systems –construction --testing – Defects and remedial measures - tube manufacture-- compounding for tyre and tube.

UNIT V  BELTING, HOSES AND FOOTWEAR
Manufacturing methods of Belting and hoses – conveyor, transmission (V and flat) belting. braided and hand–built hoses, footwear

TOTAL: 45 PERIODS

OUTCOME
• Will be aware of preparation and properties of rubbers.
• Will be conversant in manufacture and properties of tyres and Tubes.
• Will develop capacity to appreciate the properties of rubbers and their product manufacture.

REFERENCES


PO5205 POLYMES IN ENGINEERING

OBJECTIVE

• To acquire knowledge of polymers meant for electrical, electronics and high temperature applications.
• To impart basic knowledge on polymer blends, alloys and liquid crystals.
• To gain knowledge of polymers in lithography, water treatment and biomedical applications

UNIT I POLYMERS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS


UNIT II POLYMERS FOR HIGH TEMPERATURE APPLICATIONS


UNIT III POLYMER BLENDS, ALLOYS AND LIQUID CRYSTALS


UNIT IV POLYMERS IN LITHOGRAPHY AND WATER TREATMENT


TOTAL: 45 PERIODS

OUTCOME
Student Will be able to

- understand the uses polymers in electrical, electronics and high temperature fields.
- understand polymer blends, alloys and liquid crystals.
- appreciate the application of polymers in a variety of fields like water treatment, stereo lithography and biomedical areas

REFERENCES


PO5211 POLYMER TESTING LABORATORY L T P C
0 0 4 2

OBJECTIVE

- To enable students to know the testing of rubbers and plastics,
- To enable them understand the importance of thermal, electrical and optical properties of the polymeric materials.
- To understand the basic concepts of Identification, characterization, flammability and analytical testing of polymers.

MECHANICAL PROPERTIES

Mechanical properties –

1. Tensile
2. Flexural
3. Compressive
4. Impact Strength
5. hardness
6. abrasion resistance

**THERMAL PROPERTIES**

Thermal properties

7. Vicat softening temperature and heat deflection temperature
8. Brittleness temperature

**ELECTRICAL PROPERTIES**

9. Dielectric strength
10. Electrical resistance test
11. Arc resistance.

**OPTICAL PROPERTIES**

12. Refractive index
13. Transmittance, haze, gloss.

**MATERIAL CHARACTERIZATION TESTS**

MFI, thermosets – apparent (bulk) density, bulk factor, pourability, specific gravity, gel time and peak exothermic temperature, water absorption.

**OUTCOME**

Student will be able

- to practically determine thermal, electrical and optical properties of the polymeric materials.
- to recognize the basics in analytical testing of polymers.

**REFERENCES**


**Equipment needed:**

UTM, impact tester, abrasion resistance testing equipment (Pico or Tager abraders), electrical equipment for supplying high voltages, electrodes etc, prism and other optical equipment for measuring refractive index etc, MFI tester, bulk density tester, specific gravity measuring equipment.
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

**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.

**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.

**OBJECTIVE**
- To impart knowledge on packaging materials and applications.

**UNIT I**
**POLYMER PACKAGING MATERIALS**

Introduction to Packaging – Functions of packaging – Major packaging materials viz. Polyolefins, Polystyrene, Polyvinylchloride, Polysterers, 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  
**CONVERSION TECHNOLOGY-I**  
9

UNIT III  
**CONVERSION TECHNOLOGY-II**  
9
Thermoforming – Vacuum forming, Drape forming, Snap-back vacuum forming, Plug assisted vacuum forming, Pressure forming, Matched mould forming, Scrap less thermoforming, Skin pack and blister packs, Thermoform/fill/seal systems (TFFS). Advantages and disadvantages of thermoforming. Printing – Flexographic printing, Rotogravier printing, Pad printing, Hot stamping,

UNIT IV  
**PERFORMANCE EVALUATION OF PACKAGING PRODUCTS**  
9

UNIT V  
**ENVIRONMENTAL CONSIDERATION**  
9
Plastic waste – Classification, Segregation, Sorting and Waste Management viz. source reduction, reuse/repair, recycling related to packaging films and containers.

TOTAL : 45 PERIODS

OUTCOME

- Will be aware of processing methods of polymers used for packaging applications
- Will develop capacity to understand polymers employed in various fields
- Will be able to discuss the application of polymers in packaging field

REFERENCES


PO5002  
**SPECIALTY POLYMERS**  
L T P C 3 0 0 3

OBJECTIVE

- To make the student to acquire knowledge in polymers for special application.
- To provide exposure to the students about advanced polymeric materials.
UNIT I LIQUID CRYSTALLINE POLYMERS (LCPS)

Concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification. theories of liquid crystallinity, characteristics of LC state and LCPs, blends of LCPs, applications of LCPs.

UNIT II CONDUCTING POLYMERS

Theory of conduction, band theory, requirements for polymer to work as conductor, types of conducting polymers - doping of polymeric systems, Polyaniiline, Polycetylene, Polypyrrole, organometallic polymers – Photo conducting polymers- Polymers with Piezzo, ferro and pyro electric properties.

UNIT III HEAT RESISTANT POLYMERS

Requirements for heat resistance, determination of heat resistance, synthesis, structure-property relationships, applications of heat resistant polymers like polyamides, polyimides and its derivatives, polyquinolines, polyquinoxalines, Polymers for high temperature resistant-PBT, PBO, PBI, PPS, PPO, PEEK, Fluro polymers

UNIT IV PHOTOSENSITIVE POLYMERS AND POLYMERS AS COATING ADDITIVES

Photosensitive polymers - synthesis, curing reactions, applications in various fields. Photo resist for semiconductor fabrication. Membranes, their types, methods of casting and their applications. Polymer as coating additives - types, synthesis, requirements for polymer to work as coating additives and applications.

UNIT V POLYMERS IN MISCELLANEOUS SPECIALTY APPLICATIONS

Polymers in agricultural applications: green houses, control release of agricultural chemicals, seed coatings, etc., polymers in construction and building applications, polymer concrete, polymeric materials used in telecommunication and power transmission applications, polymer composites in aerospace

TOTAL: 45 Periods

OUTCOME

- Student will be aware of preparation and properties of speciality polymers
- Student will be able to methodically discuss application of speciality polymers.
- Student will appreciate the uses of polymers for speciality applications

REFERENCES


**PO5003 COMPUTER AIDED DESIGN**

**OBJECTIVE**
- To impart knowledge on Computer graphics fundamentals and Interactive computer programming.
- To be conversant with Computer animation and Mechanical assembly.
- To introduce Prototyping, process planning and CAD CAM integration.

**UNIT I COMPUTER GRAPHICS FUNDAMENTALS**

**UNIT II INTERACTIVE COMPUTER PROGRAMMING**
Requirements of interactive programming – types of interactive programming - objective oriented programming – development of interactive programme in languages like auto LISP etc. – applications.

**UNIT III COMPUTER ANIMATION**
Conventional animation – computer animation – animation requirements – animation types – animation techniques – design application

**UNIT IV MECHANICAL ASSEMBLY**

**UNIT V PROTOTYPING, PROCESS PLANNING AND CAD CAM INTEGRATION**
Basics of prototyping - principles and planning –basics of process planning and CAD CAM integration.

**OUTCOME**
- Will be able to appreciate the uses of computers in chemistry.
- Will be able to use computers as a tool in solving industrial problems.

**REFERENCES**
OBJECTIVES

- To make the student learn about temperature measurement and pressure, level and flow measurement.
- To acquaint the student physical property measurement in and process chemical analyzer.
- To know the importance of Indicating and recording instruments.

UNIT I TEMPERATURE MEASUREMENT

Introduction-Classification of temperature measuring device – thermocouple-Resistance thermometers- thermistor-radiation pyrometry-Total radiation pyrometers - optical pyrometers

UNIT II PRESSURE, LEVEL AND FLOW MEASUREMENT

Pressure –manometers, bourdan tube –bellow diaphragm, Venturi, Orifice & nozzle meters, Pitot tube, turbine type meters, hot wire anemometer, magnetic flow meters. Level measurement: float level meters & electrical conductivity meters

UNIT III PHYSICAL PROPERTY MEASUREMENT

Measurement of Density and specific gravity – Measurement of viscosity thermal conductivity measurement-Measurement of viscosity

UNIT IV PROCESS CHEMICAL ANALYZER

Chromatographic analyzers, infrared analyzers, ultraviolet and visible radiation analyzers mass spectrometers, electro analytical instruments.

UNIT V INDICATING AND RECORDING INSTRUMENTS

Recorders-recorder requirements, analog and digital recording instruments, ultraviolet recorder, Null type recorder, single point recorder

TOTAL : 45 PERIODS

OUTCOME

- Student will have a basic understanding of the engineering concepts involved in the chemical industry.
- Student will Know the importance of in physical property measurement the industrial operations.
- Can associate the reactions that he has already learnt with the actual process in the industry.

REFERENCES

2. Eckman, D.P. – Industrial Instrumentation, CBS publishers 2004(Reprint).
OBJECTIVE

- To bring a sound knowledge of theoretical and technological aspects of mechanism and characterization of adhesives.
- To understand the various types of Adhesives employed in Industries. To acquire knowledge of Applications of adhesives in various fields.

UNIT I  ADHESION MECHANISMS


UNIT II  CHARACTERIZATION OF ADHESIVES

Principle of fracture mechanics, peel, lap sheen and butt tensile tests. Pull out of an extendable fibre, various testing and evaluation of adhesives, energy dissipation – plasticity – strength of elastomers.

UNIT III  INDUSTRIAL ADHESIVES


UNIT IV  SYNTHETIC ADHESIVE TYPES

Synthetic adhesives -phenolic resin, epoxy, polysulphide, polyurethane, polyvinyl alcohol, acrylics, high temperature silicone adhesives. Water based– hot -melt adhesives – anaerobic adhesives.

UNIT V  APPLICATIONS OF ADHESIVES

Adhesives for building construction, medical use, automobile industry bonded and coated abrasives – fabrics, bonding technology for textile, metal, plastics, wood, paper and glass.

TOTAL: 45 PERIODS

OUTCOME

- Will be able to attain the basic knowledge of adhesives.
- Will be able to comprehend the utility of adhesives in industry.
- Will develop capacity to apply adhesives in various fields.

REFERENCES

1. A.V. Pocius, Adhesion and Adhesives Technology, Hanser, 2002
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  9

UNIT II  DATA COLLECTION AND SAMPLING DESIGN  9
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  9

UNIT IV  POLYMER RESEARCH  9
Polymer synthesis–structure property relation- characterization- testing- principles and methodology.

UNIT V  RESEARCH REPORTS  9
Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report

TOTAL : 45 PERIODS

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
3. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-
Hill Co. Ltd., 2006.


PO5006 SYNTHETIC FIBRES

OBJECTIVE

- To introduce the textile process and also teach about manufacture of fibre forming polymers.
- To make the student conversant with the manufacture of filament fibre and Manufacture of Staple fibre.
- To learn about texturization.

UNIT I INTRODUCTION TO TEXTILE PROCESS

Classification of fibres, yarn manufacture, fabric manufacture, wet processing of textile, testing of textile materials.

UNIT II MANUFACTURE OF FIBRE FORMING POLYMERS

Polymer production - fibre forming polymers – properties, characterization - production of polyethylene terephthalate (PET), polyester, nylon, polyacrylonitrile and polypropylene.

UNIT III MANUFACTURE OF FILAMENT FIBRE

Filament fibre manufacture - melt, wet and dry spinning of polymers- spin finishes – functions, constitution and application - post spinning operations – drawing and winding.

UNIT IV MANUFACTURE OF STAPLE FIBRE

Staple fibre manufacture - production of staple fibres – drawing of tow, heat setting, crimping and cutting - tow to top converters – advantages, principles and working of machines.

UNIT V TEXTURIZATION

Texturization - introduction, methods, false twist texturing, air jet texturing, comparison.

TOTAL: 45 PERIODS

OUTCOME

- Will be up to date with the preliminary preparation of fibers.
- Will have clear understanding of the concept of dyeing.
- Will be familiar the machinery and stages involved in textile processing.
REFERENCES


PO5007 BIOPOLYMERS AND BIODEGRADABLE POLYMERS L T P C

OBJECTIVE

- To impart knowledge on synthetic biodegradable polymers and its applications.
- To impart knowledge on principles of biodegradation and disposal of municipal waste.
- To make them get a basic knowledge about the biopolymers and their structures.

UNIT I SYNTHETIC BIODEGRADABLE POLYMERS

Biodegradable polymers - poly -caprolactone- modified poly -caprolactone copolymer with ester, amide and urethane linkages, polyglycolate, biodegradable polyamides – copolymers of - amino acid (glycine, serine ), -aminocaproic acid.– polyester urea – polyamide urethane - synthesis and properties. polyglutamic acid, bacterial polyesters.

UNIT II PRINCIPLES OF BIODEGRADATION

Biodegradation - introduction – modes of biological degradation – enzymatic degradation of biopolymers (poly saccharides, proteins, nucleic acids) and synthetic polymers - microbial degradation of synthetic polymers.

UNIT III DISPOSAL OF MUNICIPAL WASTE


UNIT IV BIOPOLYMERS

UNIT V   STRUCTURE OF BIOPOLYMERS


TOTAL: 45 PERIODS

OUTCOME

• Students will show concerned for environment by using synthetic biodegradable polymers.
• Students will be able to methodically discuss importance of waste management.
• Students will develop capacity to comprehend biopolymers and their application.

REFERENCES


PO5008   CONDUCTING POLYMERS

OBJECTIVE

• To acquire a knowledge of chemistry on conducting polymers and its conductivity.
• To understand the basic concepts of synthesis, processing and applications of conducting polymers.
• To impart knowledge on spectral, morphological, thermal, mechanical and electrochemical characterization of conductive polymers.

UNIT I   ELECTROCHEMISTRY OF CONDUCTING POLYMERS


UNIT II   SYNTHESIS, PROCESSING AND APPLICATIONS OF CONDUCTING POLYMERS

Synthesis of conducting polymers- mechanism of conduction - chemical, electrochemical and enzymatic methods – Synthesis, processing methods and applications of polyacetylene, polyaniline, polypyrrole, polythiophene and poly-paraphenylene based conducting polymers.
UNIT III ELECTROCHEMICAL CHARACTERIZATION OF CONDUCTING POLYMERS
Electro-analytical techniques – cyclic voltammetry, chronoamperometry and chrono-coulometry

UNIT IV SPECTRAL AND MORPHOLOGICAL CHARACTERIZATION OF CONDUCTING POLYMERS
FTIR, UV-vis, XRD, SEM, TEM and NMR

UNIT V MECHANICAL AND THERMAL CHARACTERIZATION OF CONDUCTING POLYMERS
UTM, Dilatometry, TGA, DTA, DSC and DMA

TOTAL: 45 PERIODS

OUTCOME
- Will get a basic idea about conducting polymers.
- Will be able to synthesis conducting polymers.
- Will be able to characterize and analyse the properties of conducting polymers.

REFERENCES

PO5071 THERMOPLASTIC ELASTOMERS LTPC 3 0 0 3

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

UNIT III  POLYURETHANE ELASTOMER  9

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  THERMO PLASTIC 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

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
- The student will have an idea about preparation technologies and applications of nanocomposites

TOTAL: 45 PERIODS
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 Siilicate and Silica Nanocomposites- Elsevier, 2005

PO5009 POLYMER BLENDS AND ALLOYS L T P C
3 0 0 3

OBJECTIVES:

- To enable the student learn about the polymer miscibility and polymer interaction in various types of polymer blends and alloys

UNIT I INTRODUCTION
Definition for Blends - Alloys and Copolymers - Reason for Blending - Classification of Polymer Blends - Miscible Blends and Immiscible Blends - Phase Equilibria Calculation - Huggins - Flory Theory

UNIT II DETERMINATION OF POLYMER/POLYMER MISCIBILITY
Methods of Measurements - Refractive Index - Ultrasonic Velocity - Thermal and Optical Methods - Factors Affects on Miscibility of Polymer Blends - Compatibility - Solubility Parameter - Interaction Parameter.

UNIT III THERMODYNAMICS, CRYSTALLIZATION AND MELTING OF POLYMER BLENDS
Introduction - Thermodynamic Principles - Thermodynamics of a Single Component Systems - Phase Separation - Methods of Measurements - Crystallization, Morphological and Melting Behavior of Polymer Blends

UNIT IV COMPATIBILIZED BLENDS AND METHODS OF TOUGHENING
Introduction - Types and Role of Compatibilizer - Compatibilization Methods - Mechanism of Compatibilized Blends - Mechanism and Theory of Toughing - Toughening of Thermoplastics

UNIT V RHEOLOGY AND APPLICATIONS OF POLYMER BLENDS AND ALLOYS
Introduction - Rheology of Miscible and Immiscible Blends - Applications - Automotive - Electrical and Electronics - Medical - Packaging

TOTAL : 45 PERIODS
OUTCOME:
- demonstrate knowledge and understanding in the blends of various polymers, its solubility parameter, compatibility and phase separation and rheology of Polymer blends and alloys

REFERENCES
3. L. M. Robeson, Polymer blends Hanser publications, USA, 2007

PO5010 REACTION ENGINEERING

OBJECTIVE
- To train students in reaction kinetics and evaluation of reaction rate and reactors.
- To make the student conversant with the heat effects in reactors and reactor stability.
- To get familiarize with chemical equilibrium constant

UNIT I REACTION KINETICS AND EVALUATION OF REACTION RATE

UNIT II REACTORS

UNIT III HEAT EFFECTS IN REACTORS
Heat effects in reactors – isothermal and non-isothermal homogeneous systems adiabatic reactors – rates of heat exchange for different reactors – design for constant rate heat input and constant heat transfer coefficient operation – batch and continuous reactors.

UNIT IV REACTOR STABILITY
Reactor stability – criteria for stability of reactors, limit cycles and oscillating reactions

UNIT V CHEMICAL EQUILIBRIA AND EQUILIBRIUM CONSTANT

TOTAL: 45 PERIODS

OUTCOME
- Will understand reaction kinetics.
- Will be able to comprehend heat effects in reactors and reactor stability.
Will be aware of different reactors, chemical equilibria and equilibrium constant

REFERENCES

PO5011 INDUSTRIAL MANAGEMENT

OBJECTIVE
- To acquire knowledge on man power planning, motivation and productivity.
- To learn the Industrial relations, public policies, leadership and management in the trade union.
- To understand the basic concepts of dynamics of conflict and collaboration and also on Workers participation and management.

UNIT I MAN POWER PLANNING

UNIT II MOTIVATION AND PRODUCTIVITY

UNIT III UNION MANAGEMENT PERSPECTIVE

UNIT IV DYNAMICS OF CONFLICT AND COLLABORATION
UNIT V WORKERS PARTICIPATION AND MANAGEMENT

Concept, strategies and practices — models in workers participation management — design and dynamics of anticipative forms — case studies — case study analysis — synthesis

TOTAL: 45 PERIODS

OUTCOME
- Will be able to manage industrial issues effectively.
- Will be concerned about labour laws and policies.

REFERENCES

PA5071 POLYMER RECYCLING

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


UNIT II RECYCLING OPERATIONS


UNIT III RECYCLING MATERIALS - I

UNIT IV RECYCLING MATERIALS- II


UNIT V RUBBER RECYCLING


TOTAL : 45 PERIODS

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


PO5072 TOTAL QUALITY MANAGEMENT L T P C

OBJECTIVES

- To provide comprehensive knowledge about the principles, practices, tools and techniques of total quality management.
UNIT I  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

OUTCOMES
- To understand 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
OBJECTIVES

- To select proper materials for mould making
- To understand the need and method of surface treatments
- To acquire the knowledge on mould manufacturing techniques
- To inspect, repair, protect and estimate the moulds

UNIT I MATERIAL FORMOULDS 9


UNIT II SURFACE TREATMENT OF MOULD MATERIALS 9

Introduction—Heat treatment process—casehardening—through hardening—nitriding—tips on successful heat treatment—vacuum hardening—cryogenic heat treatment Hard chrome plating—Nickel plating—chemical etching—Mould Polishing techniques

UNIT III MOULD MAKING TECHNIQUES 9


UNIT IV INSPECTION AND QUALITY CONTROL OF MOULDS 9

Introduction to Tool Room measuring instruments—Vernier—Micrometer—Height Gauge—Slip Gauge—Dial Gauge—Measuring tapers and angles—CMM.

UNIT V MOULD COST ESTIMATION, REPAIR AND PROTECTION 9


OUTCOMES

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

- Identify components of specific products and justify their material selection
- Describe the advantages and disadvantages of the different classes of manufacturing processes
- Describe the manufacturing processes used to fabricate mould components
- Understand surface enhancement processes in advanced manufacturing and their applications

TOTAL : 45 PERIODS
REFERENCES


PO5073 INTELLECTUAL PROPERTY RIGHTS (IPR) AND COPYRIGHT LAWS

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


UNIT II


UNIT III


UNIT IV


UNIT V

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