# M.Tech. Polymer Science and Engineering

## Semester I

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### LIST OF ELECTIVES

#### M. TECH. POLYMER SCIENCE AND ENGINEERING

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

OUTCOME
- Will be aware of preparation and properties of polymers at length.
- Will be able to methodically discuss moulding techniques
- Will develop capacity to characterize polymers and draw a parallel to their properties

UNIT I  FUNDAMENTALS OF POLYMERS
9

UNIT II  BIO AND INORGANIC POLYMERS
9

UNIT III  CHAIN POLYMERIZATION
9

UNIT IV  STEP GROWTH POLYMERIZATIONS AND COPOLYMERIZATION
9

UNIT V  MOLECULAR WEIGHT, SOLUBILITY AND FRACTIONATION OF POLYMERS
9

REFERENCES
OBJECTIVES
- The objective of this course is introduction to polymer structure, chain structure and mechanical properties.
- To impart knowledge on thermal properties and electrical properties.
- Students should be conversant with rheological properties.

OUTCOME
- Will be aware of preparation and properties of polymers at length.
- Will be able to discuss the properties of polymers.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

UNIT I INTRODUCTION 9
Polymer structure – chain structure – micro structure – crystal structure- crystallinity – determination of crystallinity, size and orientation of crystallites using x-rays-conformation and configuration.

UNIT II MECHANICAL PROPERTIES 9

UNIT III THERMAL PROPERTIES 9
Enthalpy –melting and crystallization – importance of Tg - factors affecting Tg – determination of Tg – thermal conductivity – thermal expansion and contraction - factors affecting thermal expansion.

UNIT IV ELECTRICAL PROPERTIES 9
Electrical properties at low stress and high stress- breakdown mechanisms – electrically conductive plastics – electrical applications of plastics.

UNIT V RHEOLOGICAL PROPERTIES 9

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- 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 die design

OUTCOME
- Will be aware of different mixing devices, extrusion moulding.
- Will be able to methodically discuss moulding techniques.
- Will understand the basic concepts in die design

UNIT I  MIXING DEVICES  9

UNIT II  EXTRUSION MOULDING  10

UNIT III  INJECTION MOULDING  8

UNIT IV  SPECIAL MOULDING TECHNIQUES  9

UNIT V  BASIC CONCEPTS IN DIE DESIGN  9
Types of moulds – ejector system – ejection techniques – mould cooling – CAD / CAM applications

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To make the student conversant with polymer synthesis, kinetics of polymerization
- To enable students develop their determination of reactivity ratio and molecular weight.
- To know the importance of fractionation of polymers

OUTCOME
- Will be aware of synthesis and kinetics of polymers.
- Will be able to methodically discuss fractionation of polymers.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

UNIT I
Polymer synthesis – bulk, solution, emulsion, suspension and slurry polymerization - low and high temperature condensation polymerization, interfacial polycondensation, thermal and redox initiated polymerizations

UNIT II
Kinetics of polymerization – dilatometry, gravimetry.

UNIT III

UNIT IV
Determination Molecular weight Molecular weight determination – viscometry, end group analysis, GPC, light scattering, osmometry

UNIT V
Fractionation of polymers – Fractional precipitation method – polydispersity.

TOTAL : 60 PERIODS

TEXT BOOKS

PO7201 CHARACTERIZATION AND TESTING OF POLYMERS

OBJECTIVES
- To pass on knowledge on characterization tests, thermal and electrical properties.
- To learn mechanical properties and flammability, optical properties and analytical tests.
- To provide exposure to understand the testing of foam plastics and testing organizations.

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 of foam plastics and testing organizations.
UNIT I CHARACTERIZATION TESTS

TGA, DTA, DSC, TMA, XRD, SEM, AFM, TEM, IR, NMR, GC, GPC melt index and viscosity.

UNIT II THERMAL AND ELECTRICAL PROPERTIES

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

UNIT III MECHANICAL PROPERTIES AND FLAMMABILITY

Tensile tests, compressive properties, impact properties, deformation, brittleness abrasion resistance hardness tests – incandescence resistance, ignition properties, oxygen index, surface burning characteristics.

UNIT IV OPTICAL PROPERTIES AND ANALYTICAL TESTS

Refractive index, luminous transmittance, haze, density, water absorption, moisture analysis, sieve analysis, crush and burst strength.

UNIT V TESTING OF FOAM PLASTICS AND TESTING ORGANIZATIONS

Foam properties, rigid and flexible foam - testing methods - ASTM, ANSI, NBS, NEMA, NFPA, UL, SPI and SPE.

TOTAL : 45 PERIODS

REFERENCES


PO7202 POLYMER COMPOSITES L T P C

3 0 0 3

OBJECTIVES

• The objectives of this paper is to introduce in detail the basics of polymer composites

OUTCOME

• On completion of the paper the student should be able to demonstrate knowledge and understanding in the matrix, reinforcement and additives used in polymer composites. The student will also understand the properties of laminates, processing and applications of composites.

UNIT I INTRODUCTION AND MATRIX MATERIALS

Introduction - Characteristics - Advantages - Classification - Particulate, Fibrous and Laminated Composites - Hybrid Composites - Matrix Resins - Unsaturated Polyester - Vinyl Ester - Epoxy- Phenol Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde Resin - Production - Properties and Applications
UNIT II          REINFORCEMENT MATERIALS  

UNIT III          ADDITIVES AND PROCESSING OF COMPOSITES  

UNIT IV          LAMINATED COMPOSITES  

UNIT V          TESTING AND APPLICATION OF COMPOSITES  

TOTAL : 45 PERIODS

REFERENCES

PO7203          PHYSICS OF POLYMERIC MATERIALS  
L T P C 3 0 0 3

OBJECTIVES
- The objectives of this paper is to introduce the physics of polymeric materials

OUTCOME
- On completion of the paper the student should be able to demonstrate knowledge and understanding in chain conformation, thermodynamics of polymer solutions, theory of gelation and polymer dynamics
UNIT I  BASICS OF POLYMER PHYSICS  9
Polymer Microstructure - Fractal Nature of Polymer Conformations - Types of Polymeric Substances (Liquid, Solid and Crystal) - Molar Mass Distributions and Measurements - Molecular Sizes and Shapes and Ordered Structures - Tacticity - Crystallinity - Elasticity of Isolated Polymer Chain and of the Network - Rubber Elasticity

UNIT II  CHAIN CONFORMATIONS  9
Ideal Chains - Flexibility Mechanisms - Conformation - Chain Models - Radius of Gyration (Linear, Branched and Rod Polymer) - Distribution of End to End Vectors - Free Energy and Pair Correlations of an Ideal Chain - Measure of Size by Scattering - Real Chains - Excluded Volume and Self Avoiding Walks - Deforming Real and Ideal Chains (Polymer Under Tension and Compression, Adsorption of Single Chain) - Temperature Effects on Real Chains (Scaling Model, Flory Theory, Temperature Dependence of the Chain and Second Virial Coefficient) - Distribution of End to End Vectors - Scattering from Dilute Solutions

UNIT III  THERMODYNAMICS OF SOLUTIONS AND BLENDS  9
Thermodynamics of Mixing - Entropy and Energy of Binary Mixing - Equilibrium and Stability - Phase Diagram - Mixtures at Low Compositions (Osmotic Pressure and Polymer Melts) - Experimental Investigations of Binary Mixtures - Polymer Solutions - Theta and Poor Solvent - Good Solvents (Correlation Length and Chain Size and Osmotic Pressure) - Semidilute Theta Solutions (Correlation Length and Osmotic Pressure) - Alexander De Gennes Brush Theory - Multi Chain Adsorption - Measuring Semidilute Chain Conformations

UNIT IV  NETWORKS AND GELATION  9
Random Branching and Gelation - Introduction - Branching without Gelation - Gelation Concepts and Definitions - Mean Field Model of Gelation (Gel Point, Sol-Gel Fractions, Number and Weight Average Molar Mass Below the Gel Point, Molar Mass Distribution, Size of Ideal Randomly Branched Polymers) - Scaling Model of Gelation (Molar Mass Distribution and Gel Fraction, Cut-off Functions, Size and Overlap of Randomly Branched Polymers) - Characterization of Branching and Gelation - Networks and Gels - Thermodynamics of Rubbers (Flory Construction) - Unentangled and Entangled Rubber Elasticity - Swelling of Polymer Gels - Networks in the Gelation Regime - Linear Visco Elasticity

UNIT V  POLYMER DYNAMICS  9
Unentangled Polymer Dynamics - Intrinsic Viscosity - Relaxation Modes - Semi Dilute Unentangled Solutions - Modes of Semi Flexible Chains - Temperature Dependence of Dynamics - Dynamic Scattering - Entangled Polymer Dynamics - Entanglements in Polymer Melts - Reptation in Polymer Melts and Semi Dilute Solutions - Dynamics of Single Entangled Chain - Many Chain Effects - (Constrained Release) - Computer Simulations in Polymer Physics

REFERENCES

TOTAL : 45 PERIODS

PO7211 POLYMER PROCESSING AND TESTING LABORATORY  L T P C
                                        0 0 6 3

OBJECTIVES
• To enable students to know the processing of polymers and testing of plastics etc.,
• To know 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.
OUTCOME

- Will be able to develop methods for processing of polymers and testing of plastics etc.
- Will be able to discuss thermal, electrical and optical properties of the polymeric materials.
- Will be able to recognize the basics in analytical testing of polymers.

UNIT I PROCESSING OF POLYMERS
Processing of polymers – principles of compounding and processing for the manufacture of plastics and rubber products - injection, blow and compression moulding, extrusion, calendaring and casting processes.

UNIT II TESTING OF PLASTICS
Testing of plastics and dry rubber products – mechanical properties – tensile, Flexural, compressive, impact, hardness, abrasion and fatigue resistance tests.

UNIT III THERMAL PROPERTIES
Thermal properties – thermal conductivity, thermal expansion and brittleness temperature, heat deflection temperature.

UNIT IV ELECTRICAL PROPERTIES
Electrical properties – dielectric strength, dielectric constant and dissipation factor. Electrical resistance tests - arc resistance.

UNIT V OPTICAL PROPERTIES
Optical properties – refractive index, transmittance and haze, gloss.

UNIT VI MATERIAL CHARACTERIZATION
Material characterization tests – thermoplastics – MFI, capillary rheometer test – thermosets – apparent (bulk) density, bulk factor, pourability, viscosity (Brookfield), gel time and peak exothermic temperature.

UNIT VII FLAMMABILITY TESTS
Flammability tests – oxygen index test, ignition temperature determination.

UNIT VIII ANALYTICAL TESTS
Analytical tests – specific gravity, density, water absorption, moisture analysis.

UNIT IX ANALYSIS OF PLASTICS
Identification and analysis of plastic and dry rubber materials – chemical and thermal analysis for identification of polymers.

TOTAL : 90 PERIODS

REFERENCES

PO7001 ADHESIVE SCIENCE AND TECHNOLOGY

OBJECTIVES

- 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.
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.

UNIT I  ADHESION MECHANISM  9

UNIT II  CHARACTERIZATION OF ADHESIVES  9
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 ADHESIVE  9

UNIT IV  ADHESIVE TYPES  9

UNIT V  APPLICATIONS OF ADHESIVES  9
Adhesives for building construction, medical use, automobile industry bonded and coated abrasives – fabrics, cyanoacrylate based adhesives, bonding technology for textile, metal, plastics, wood, paper and glass.

TOTAL : 45 PERIODS

REFERENCES
5. A.V. Pocius, Adhesion and Adhesives Technology, Hanser, 2002
UNIT I  FUNDAMENTALS OF RUBBER
Criteria for a polymer to behave as a rubber – structure vs Tg, chemical, mechanical and electrical properties – polymerization types and techniques involved in production of general purpose rubbers – 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  SPECIALTY RUBBERS

UNIT III  PROCESSING OF RUBBER

UNIT IV  MANUFACTURE OF TYRE AND TUBES

UNIT V  BELTING, HOSES AND FOOTWEAR

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
To learn about types of tyres, design and fabrication of tyre

OUTCOME
Understanding of the various components used and their functions in tyres, designing and suitable compounding formulation for various tyre components and quality control in tyres

UNIT I
HISTORY AND TYPES OF TYRES
A Historical Introduction on the Design and Development of Tyres- Current Status of Tyre Industry in India and Its Future Prospectus- Tyre Sizing and Marking on the Tyres - Various Kinds and Types - Bias - Bias Belted Radial - Tube Type and Tubeless Tyres - Basic Features and Performance Comparison

UNIT II
BASICS
Tyre Terminology - Different Components of Tyre - Geometry - Basic Functions - Functions of a Pneumatic Tyre - Load Carrying - Vibration and Noise Reduction - Tyre Function as a Spring - Contribution to Driving Control and Road Adhesion - Tyre Friction Contribution to Driving Control - Steering Control and Self Aligning Torque

UNIT III
MANUFACTURING OF TYRES

UNIT IV
QUALITY CONTROL, TUBES AND MACHINERIES
Tyre Curing Methods - Post Cure Inflation - Quality Control Tests - Tyre Related Products - Design and Manufacturing Techniques - Tubes - Valves - Flaps and Bladders - Different Types - Feature and Operation of Tyre Building Machines - Bead Winding Machine - Wire/Glass Processing Machines - Bias Cutters - Curing Presses

UNIT V
TESTING AND STANDARDS OF TYRES
Measurement of Tyre Properties - Dimension and Size-Static and Loaded - Tyre Construction Analysis - Endurance Test Wheel and Plunger Tests - Traction - Noise Measurements - Cornering Coefficient Aligning Torque Coefficient - Load Sensitivity and Load Transfer Sensitivity - Rolling Resistance - Foot Print Pressure Distribution - BIS Standards For Tyres - Tubes and Flaps

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES

- To acquire knowledge on the classification of natural, synthetic polymers and its commercial applications.
- To understand the basic concepts of water soluble polymers and its applications in various fields.
- To understand the concepts of thermoplastics and thermosetting resins, the importance of rubbers, fibers and plastics and their engineering applications.

OUTCOME

- Will be aware of classification of polymers
- Will develop capacity to appreciate the applications of natural and synthetic polymers.

UNIT I  CLASSIFICATION OF POLYMERS


UNIT II  WATER SOLUBLE POLYMERS


UNIT III  THERMOPLASTIC RESINS


UNIT IV  THERMOSETTING RESINS


UNIT V  RUBBERS, FIBERS AND PLASTICS


TOTAL : 45 PERIODS

REFERENCES

OBJECTIVES:
To learn about the coating materials and their applications

OUTCOME:
Familiarization of the formulations of various types of coating materials and evaluation of properties of surface coatings and paints

UNIT I INTRODUCTION
Introduction to Surface Coatings - Components of Paints - Pigments - Pigment Properties - Different Types - Extenders - Solvents - Oils - Driers - Diluents - Lacquers - Varnishes - Paint Preparation - Formulation - Factors Affecting Pigment Dispersion - Preparation Of Pigment Dispersion

UNIT II PAINT FORMULATION AND PROPERTIES

UNIT III CLASSIFICATION AND APPLICATIONS
Different Types of Paints - Classification Based on Polymeric Resin - Emulsion - Oil and Alkyd Paints - Acrylic Paints - Epoxy Coatings - Polyurethane - Silicones - Chlorinated Rubbers - Fluoropolymers - Vinyl Resins - Classification Based on Application - Appliance Furnishes - Automotive Finishes - Coil Coatings - Can Coatings - Marine Coatings - Aircraft Coatings

UNIT IV MATHEMATICS OF PAINT FORMULATION
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.) - State of the Art Technologies - Specialty Coatings (Radiation Curable, Nonpolluting, Powder, High Solids Etc.)

UNIT V WATER BORNE COATINGS

TOTAL : 45 PERIODS

REFERENCES
3. R. Woodbridge, Editor, Principles of Paint Formulation, Blackie, 1991
OBJECTIVES

- 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 teach Texturization.

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.

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

REFERENCES


PO7007 CONDUCTING POLYMERS

OBJECTIVES

- 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.

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

UNIT I  ELECTROCHEMISTRY OF CONDUCTING POLYMER  9

UNIT II  SYNTHESIS, PROCESSING AND APPLICATIONS OF CONDUCTING POLYMERS  12
Synthesis of conducting polymers – 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  7
Electro-analytical techniques – cyclic voltammetry, chronoamperometry and chronocoulometry

UNIT IV  SPECTRAL AND MORPHOLOGICAL CHARACTERIZATION OF CONDUCTING POLYMERS  9
FTIR, UV-vis, Raman, XRD, SEM, TEM and NMR

UNIT V  MECHANICAL AND THERMAL CHARACTERIZATION OF CONDUCTING POLYMERS  8
UTM, Dilatometry, TGA, DTA, DSC and DMA

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- 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.

OUTCOME
- Will be able to apply polymers to electrical, electronics and high temperature fields.
- Will understand polymer blends, alloys and liquid crystals.
- Will appreciate the application of polymers in a variety of fields.

UNIT I POLYMERS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS
10
Engineering plastics – polymers in electrical and electronics industry – electro conducting polymers – polymer batteries – electrets - polymers with piezoelectric, pyroelectric and ferroelectric properties

UNIT II POLYMERS FOR HIGH TEMPERATURE APPLICATIONS
10

UNIT III POLYMER BLENDS, ALLOYS AND LIQUID CRYSTALS
10

UNIT IV POLYMERS IN LITHOGRAPHY AND WATER TREATMENT
10

UNIT V POLYMERS FOR BIOMEDICAL APPLICATIONS
5

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES
- To make the student familiar with the polymer wastes and primary and secondary recycling.
- To acquaint the student with tertiary and quaternary recycling, recycling of plastics.
- To introduce to students with recycling of plastics.

OUTCOME
- Will be aware of plastics waste management.
- Will develop techniques for recycling of plastics.
- Will develop concern for environment and develop skills to address the same

UNIT I POLYMER WASTES
9
Sources of plastics waste – definitions - generation of industrial plastic waste - plastic in solid waste; Separation of components in municipal refuse - separation process specific to plastics- legal aspects.

UNIT II PRIMARY AND SECONDARY RECYCLING
9

UNIT III TERTIARY AND QUATERNARY RECYCLING
9

UNIT IV RECYCLING OF PLASTICS
9

UNIT V RECYCLING PROCESSES
9

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To learn about the basic concepts in synthesis, processing and applications of polymer nanocomposites

OUTCOME
- On completion of the paper the student should be able to demonstrate knowledge and understanding in the basics, properties, rheology, processing and structural aspects of polymer nanocomposites

UNIT I BASIC AND PREPARATION OF NANOCOMPOSITES 10

UNIT II PROPERTIES OF NANOCOMPOSITES 10

UNIT III RHEOLOGY OF NANOCOMPOSITE 10
Rheology of Multi Phase Systems and Polymer / Clay Nanocomposites - Steady Shear Rheology - Dynamic Rheology - Non Linear Viscoelastic Properties - Extensional Rheology - Extensional Rheology

UNIT IV PROCESSING OF NANOCOMPOSITES 10
Extrusion - Dispersion of Clay - Effect of Extruder Types - Effect of Processing Conditions - Injection Molding - Blow Molding - Foaming - Rotational Molding

UNIT V STRUCTURE AND PROPERTIES CHARACTERIZATION 5

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To acquire knowledge on synthetic biodegradable polymers and its applications.
- To gain knowledge on principles of biodegradation and disposal of municipal waste.
- To study about the biopolymers and their structures.

OUTCOME
- Will be concerned for environment by synthesizing synthetic biodegradable polymers.
- Will be able to methodically discuss importance of waste management.
- Will develop capacity to comprehend biopolymers and their application.

UNIT I  SYNTHETIC BIODEGRADABLE POLYMERS  11
Biodegradable polymers - polyε-caprolactone- modified poly ε-caprolactone copolymer with ester, amide and urethane linkages, polyglycolate, polymandelic acid. Copolymer of 1,4-butenediol with adipic acid and sebacic acid, polyalkylene tartrate cellulose block copolymers - biodegradable polyamides – copolymers of α-amino acid (glycine, serine ), ε-aminocaproic acid. Benzyl substituted urethane – polyester urea – polyamide urethane - synthesis and properties. γ-polyglutamic acid, bacterial polyesters. Applications – agriculture, medicine, packaging.

UNIT II  PRINCIPLES OF BIODEGRADATION  9
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  8

UNIT IV  BIOPOLYMERS  8

UNIT V  STRUCTURE OF BIOPOLYMERS  8
Proteins, nucleic acids and polysaccharides – the macromolecular structure and biological functions of polymers- primary, secondary, tertiary and quaternary structure of polymers – structure maintenance and transmission of the biological information- structure and enzymatic activity – mechano structural function of biopolymers - viruses and phages – living macromolecules.

TOTAL : 45 PERIODS

REFERENCES
5. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993
OBJECTIVES
- To learn about the synthesis, properties and applications of specialty polymers

OUTCOME
- Understanding of the synthesis, manufacture, properties and special applications of silicones, high performance polymers, dendrimers and template polymerization will be the outcome after studying this paper

UNIT I  SILICONE POLYMERS  9

UNIT II  TEMPLATE POLYMERIZATION  9
Mechanism of Template Polymerization - Template Polycondensation - Chain Template Polymerization - Template Copolymerization - Polyacids, Polyimines, Polyamines, Poly(ethylene oxide), Poly(vinyl pyrrolidone), Poly(methyl methacrylate), Poly(vinylpyridines) as Templates - Ring Opening Template Copolymerization - Radical Template Copolymerization

UNIT III  HIGH PERFORMANCE POLYMERS - I  9
Carbazole Polymers - N-Vinylcarbazole - Polymerization and Fabrication - Properties and Applications - Poly(p-xylylene)s - Monomers - Polymerization and Fabrication - Properties and Applications - Poly(arylene vinylene)s - Monomers - Polymerization and Fabrication - Properties and Applications

UNIT IV  HIGH PERFORMANCE POLYMERS - II  9
Poly(arylene ether nitrile)s - Halogenated Benzonitriles - Aromatic Hydroxy Compounds - Polymerization and Fabrication - Electrophilic and Nucleophilic Route - Properties and Applications - Triazole Polymers - Polymerization and Fabrication - Properties and Applications - Poly(oxadiazole)s - Monomers - Polycondensation - Anionic Polymerization - Sulfonation - Properties and Applications

UNIT V  DENDRIMERS  9

REFERENCES
OBJECTIVES

- To learn about die and mold parts and their design

OUTCOME

- Understanding the basic principle of product design, classification of the dies and selection of suitable materials for dies will be the outcome

UNIT I PRODUCT DESIGN


UNIT II SCREW DESIGN

Extrusion Die Design - Construction Features of an Extruder - Process - Characteristics of Polymer Melt - Die Geometry - Die Head Pressure - Characteristics of Land Length to Profile Thickness - Extrudate Die Swell - Die Materials - Classification of Dies - Dies for Solid Section - Dies for Hollow Profiles - Blown Film Dies - Flat Film Dies - Parison Dies - Wire and Cable Coating Dies - Spiral Mandrel Die - Fish Tail Die - Adjustable Core Die

UNIT III MOULD DESIGN


UNIT IV MOULD MAKING

Mold Making - Introduction of Mold Parts - Mechanism of Metal Cutting - Types of Tools - Influence of Tool Angles - Cutting Fluids - Tool Materials Used Including Coated Tools - Studies of Various Machining Operations - Turning - Shaping - Planning - Drilling - Grinding (Surface, Cylindrical, Tool & Cutter, Rotary Grinding) - Milling (Horizontal / Copy Milling / Vertical / Ram / Tool Milling) - Die Sinking (Copy Milling) - Pentograph - Profile Grinding - Electrical Discharge Machining - Characteristics - Physical Processes - Special Technological Features - Types of EDM - Design Consideration and Functions and Technological Planning - Applications of Wire Cut EDM in Mold Making

UNIT V ELECTROFORMING FOR MOLD MANUFACTURING


REFERENCES:

1. R.G.W. Pye, Injection Mould Design for Thermoplastics, Published for The Plastics Institute [by] Lliffe, 1968
OBJECTIVES:
To learn about the polymer miscibility and polymer interaction in various types of polymer blends and alloys

OUTCOME:
On completion of the paper the student should be able to demonstrate knowledge and understanding in the blends of various polymers, its solubility parameter, compatibility and phase separation

UNIT I INTRODUCTION

UNIT II DETERMINATION OF POLYMER/POLYMER MISCIBILITY
Phase Equilibria Methods - Measurement of Polymer/Polymer Interaction Parameter - Indirect Methods - Methods of Measurements - Refractive Index - Ultrasonic Velocity - Thermal and Optical Methods - Factors Affects on Miscibility of Polymer Blends - Compatibility - Solubility Parameter - Interaction Parameter - Composition - Molecular Weight - Transition Temperature

UNIT III THERMODYNAMICS, CRYSTALLIZATION AND MELTING OF POLYMER BLENDS

UNIT IV COMPATIBILIZED BLENDS AND METHODS OF TOUGHENING
Introduction - Types and Role of Compatibilizer - Compatibilization Methods - Mechanism and Properties of Compatibilized Blends - Mechanism and Theory of Toughing - Toughening of Thermoplastics and Thermosets - Thermoplastic Elastomers - Introduction - Properties and Uses with Examples

UNIT V RHEOLOGY AND APPLICATIONS OF POLYMER BLENDS AND ALLOYS
Introduction - Rheological Models for Miscible and Immiscible Blends - Rheology of Miscible and Immiscible Blends - Applications - Automotive - Electrical and Electronics - Medical - Building and Construction - Business Machines and Communications – Packaging

TOTAL : 45 PERIODS

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

- To impart knowledge on Computer graphics fundamentals and Interactive computer programming.
- The students should be conversant with Computer animation and Mechanical assembly.
- To introduce Proto typing, process planning and CAD CAM integration.

OUTCOME

- Will be able to appreciate incorporation of computers in chemistry.
- Will be able to use computers as a tool in solving chemistry related problems.
- Will be able to create programs for direct use in problem solving.

UNIT I COMPUTER GRAPHICS FUNDAMENTALS 10

UNIT II INTERACTIVE COMPUTER PROGRAMMING 10
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 10
Conventional animation – computer animation – animation requirements – animation types – animation techniques – design application

UNIT IV MECHANICAL ASSEMBLY 5

UNIT V PROTOTYPING, PROCESS PLANNING AND CAD CAM INTEGRATION 10
Basics of prototyping - principles and planning –basics of process planning and CAD CAM integration.

TOTAL : 45 PERIODS

REFERENCES

OBJECTIVES

- 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 familiarize chemical equilibria and equilibrium constant to students.

OUTCOME

- Will understand reaction kinetics.
- Will be able to comprehend heat effects in reactors and reactor stability.
- Will be aware of different reactors.
- Can grasp the idea of chemical equilibria and equilibrium constant.
UNIT I REACTION KINETICS AND EVALUATION OF REACTION RATE 12
Reaction kinetics – rate equation – elementary, non-elementary reactions – mechanism –
temperature dependence of reaction rates – analysis of experimental reactor data –
evaluation of reaction rate – integral and differential analysis for constant and variable
volume system.

UNIT II REACTORS 12
Ideal reactors – homogeneous reaction systems – batch, stirred tank and tubular flow
reactor – design for multiple reactions – choice, yield, conversion, selectivity, reactivity –
consecutive, parallel and mixed reactions.

UNIT III HEAT EFFECTS IN REACTORS 12
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 4
Reactor stability – criteria for stability of reactors, limit cycles and oscillating reactions

UNIT V CHEMICAL EQUILIBRIA AND EQUILIBRIUM CONSTANT 5
Reaction equilibria – equilibrium in chemically reactive system – evaluation of equilibrium
constant – effects of temperature on equilibrium – equilibrium composition evaluation.

TOTAL : 45 PERIODS

REFERENCES
1. Octave Levenspiel, Chemical Reaction Engineering (3rd Edition), John Wiley & Sons,
1998
1981
Hall,

PO7017 PROCESS INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES
• To 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.

OUTCOME
• Will have a basic understanding of the engineering concepts involved in the chemical
  industry.
• Knows 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

UNIT I TEMPERATURE MEASUREMENT 9
Differential expansion and fluid expansion types - resistance thermometers - thermoelectric
pyrometers - radiation pyrometers - optical pyrometers - pyrometric cones - ultrasonic thin
wire thermometer - location of temperature measuring devices in equipment.

UNIT II PRESSURE, LEVEL AND FLOW MEASUREMENT 9
Liquid types and spring balanced type pressure measuring devices - manometer and sealed
belt types of pressure measuring equipment - pressure transmitters - various types of level
measuring equipment - volumetric, variable head meters for flow measurement - variable
area meters - velocity and current meters - ultrasonic flow meters - mass meters.
UNIT III  PHYSICAL PROPERTY MEASUREMENT  9
Density and specific gravity - viscosity and consistency - refractive index analysers - boiling point and flash point analyzers - thermal conductivity measurement - moisture measurement.

UNIT IV  PROCESS CHEMICAL ANALYZER  9
Chromatographic analyzers, infrared analyzers, ultraviolet and visible radiation analyzers, mass spectrometers, electro analytical instruments.

UNIT V  INDICATING AND RECORDING INSTRUMENTS  9
Measurement to indicator transducers, analog and digital indicating and recording instruments, variables of importance to various industries and their measurement.

REFERENCES

PO7018  HEAT TRANSFER AND MOMENTUM TRANSFER PROCESS  L T P C 3 0 0 3

OBJECTIVES
- To acquire knowledge on momentum transport process and solution to equations of motion.
- To understand the basic concepts of heat transfer by conduction process and convective heat transfer process.
- To know the importance of mass transfer.

OUTCOME
- Will be aware of momentum transport process and solution to equations of motion.
- Will be able to methodically discuss heat transfer process.
- Will understand the importance of mass transfer.

UNIT I  MOMENTUM TRANSPORT PROCESS  10
Momentum transport – fluid behavior – overall mass, energy and momentum balances – differential mass, energy and momentum balance-polymeric liquids.

UNIT II  SOLUTION TO EQUATIONS OF MOTION  9
Solution to equations of motion - flow measurement - boundary layer flow – turbulent flow – dimensional analysis applied to momentum transport – design equation for incompressible fluid- flow through packed column–fluidization.

UNIT III  HEAT TRANSFER BY CONDUCTION PROCESS  8

UNIT IV  CONVECTIVE HEAT TRANSFER PROCESS  8
Convective heat transfer – heat transfer in laminar and turbulent flow- boiling and condensation – design equations for convective heat transfer – heat exchangers.
UNIT V  
MASS TRANSFER 
Mass transfer – molecular diffusion – binary systems – convective mass transfer coefficients – mass transfer in laminar and turbulent flow – design equations for convective mass transfer – analysis between momentum, heat and mass transfer.

TOTAL : 45 PERIODS

REFERENCES
4. C.J. Geankoplis, Transport Processes – Momentum, Heat and Mass (Allyn and
5. Bacon Inc), Boston, USA 1983.

PO7019  
INDUSTRIAL MANAGEMENT  

OBJECTIVES
- 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.

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

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

REFERENCES
3. C.B. Memoria and S. Memoria, Dynamics of Industrial Relations in India, Himalaya Publishing co., Bombay, 1985

TOTAL : 45 PERIODS

PO7020 TOTAL QUALITY MANAGEMENT L T P C

3 0 0 3

OBJECTIVES

- To impart knowledge on the theory of quality control, quality capability study.
- To introduce knowledge on quality assurance and acceptance, sampling plans and tables.
- To acquaint the students about quality engineering, reliability and maintainability in enterprises management.

OUTCOME

- Will develop management skills.
- Will build up concern for quality and its maintenance.

UNIT I


UNIT II


UNIT III

Quality assurance and acceptance – acceptance sampling-operating characteristics curve – development of single sampling plan, concept of AQL, LTPD producers and consumers risk – average outgoing quality (AOQ) curve. Other acceptance sampling plans – sampling tables.

UNIT IV


UNIT V

REFERENCES