PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To equip graduates with good scientific and engineering knowledge so as to help comprehend, analyze, design, and create new products based on rubber and rubber like materials, for various engineering applications

II. To prepare graduates to excel in inter-disciplinary research required for the Rubber Industry and/or Research Organizations, with an ethical and social outlook

III. To provide graduates with an academic environment, conducive for research and development in their life-long learning in various aspects of their profession

PROGRAMME OUTCOMES (POs):

On successful completion of the programme, the Post Graduates will

1. Acquire adequate knowledge of scientific and technological aspects of rubber and allied products

2. Have the ability to identify, formulate and solve engineering problems related to rubber product design and manufacture

3. Be capable of designing new components and processes as per needs and specifications for rubber and allied industries

4. Demonstrate the ability to design, experiment, analyze and interpret data for product validation

5. Understand, simulate and work on products and integrate multidisciplinary tasks pertaining to rubber technology

6. Demonstrate skills to use modern engineering tools, software and equipment to analyze and solve problems

7. Be able to provide technical and/or academic leadership for various organizations through life-long learning

8. Develop confidence and tools necessary for technology forecasting including social and environmental aspects.
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| Rubber Compounding                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Rubber Products Design            | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Tyre Science and Technology       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Elective-II                       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Elective-III                      | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
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## Employability Enhancement Courses (EEC)

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*THEORY*
OBJECTIVE

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

OUTCOME

By the end of this course, students will be able to
- It helps the students to get familiarized with the numerical methods which are necessary to solve numerically the problems that arise in engineering.

UNIT I   ALGEBRAIC EQUATIONS  12

UNIT II  ORDINARY DIFFERENTIAL EQUATIONS  12
Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth Multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION  12

UNIT IV   FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS  12
Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V   FINITE ELEMENT METHOD  12

TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCE
OBJECTIVE
- To introduce the concepts of design in common machine elements for engineering applications.

UNIT I ENGINEERING DESIGN CONCEPTS
Stress-Strain relations - Mohr’s circle- Shear force - Bending moment diagram - Deflection of beams. Factor of safety-Preferred numbers -Various stresses in Design-Design steps

UNIT II FRICTION
Nature of surfaces and contact – Friction mechanisms and limiting angle of friction – Friction on screw and nut – Pivot and collar friction – Belt friction – Plate and disc clutches – Brakes – Application of journal bearings and rolling element bearings – Hydrostatic and aerostatic bearings.

UNIT III DESIGN OF MACHINE ELEMENTS
Design of shafts – Couplings - Journal Bearings - springs – power screws

UNIT IV DESIGN OF TRANSMISSION ELEMENTS
Belt and chain drives – Design of gear drives – Spur gear – Worm and worm wheel.

UNIT V MECHANICAL VIBRATION

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To impart fundamental knowledge on chemistry of polymers.
- To understand the structure – property relationship and applications of polymers in various fields.

OUTCOMES
By the end of this course, students will be able to
- Analyze the mechanism of polymerization in the synthesis of various polymers.
- Apply the structure – property relationship in arriving at a decided property.

UNIT I  INTRODUCTION

UNIT II  POLYMER FORMATION
Monomers – Functionality – Polymerization - Various steps in addition - Polymerization - Homo and Copolymerization – Examples – Condensation Polymerization – Examples – Simple reactions – Molecular weight of Polymers and their significance - Industrial Polymerization Techniques

UNIT III  STATES OF AGGREGATION IN POLYMERS

UNIT IV  STRUCTURE PROPERTY RELATIONSHIPS IN POLYMERS
Chemical structure-amorphous and crystalline states – Crystallization dynamics - Influence of microstructure on performance properties - Effect of Chemical structure on Mechanical, Chemical, Electrical and Optical Properties of Polymers

UNIT V  MECHANICAL PROPERTIES OF POLYMERS
Stress-Strain Behavior of polymers –Tensile, Flexural, Fatigue, Compressive Hardness and Impact properties, viscoelastic behavior of polymers, creep and stress relaxation, dynamic mechanical analysis of polymers.

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To know about the preparation, properties and application of different rubbers.
- To realize the need for vulcanization.
- To learn about the role various ingredients used in a rubber compounding.

OUTCOMES
By the end of this course, students will be able to
- Select an appropriate rubber for a given application.
- Design a formulation for a specific requirement.

UNIT I INTRODUCTION TO RUBBER MATERIALS 10
Structure-property relationships in rubbers-structure and rubber elasticity-effect of structure on Tg – influence of chemical structure on thermal and mechanical properties and chemical resistance

UNIT II GENERAL PURPOSE RUBBERS 10

UNIT III SPECIAL PURPOSE RUBBERS 10
Need – IIR, EPRs, NBR, CR, HNBR, ACM, EMA, EVA, CSM, CM, epichlorohydrin rubbers – polysulphide rubbers,

UNIT IV HIGH PERFORMANCE RUBBERS 7
Fluorine containing rubbers and silicones – their preparation, properties, curing and uses

UNIT V POLYURETHANES AND THERMOPLASTIC RUBBERS 8
SBS, PP-EPDM blends, PU, poly amide and poly ester based TPEs, blend type TPEs - plasticized PVC, castable and millable rubbers based on PU – processing advantages of PUs in foams, RIM products

REFERENCES
OBJECTIVES

- To study the rheological characteristics of a polymer.
- To introduce the different rubber processing techniques.

OUTCOMES

By the end of this course, students will be able to

- Decide the processing parameters for a specific rubber product within realistic constraints.
- Solve the product defect due to rheological behavior and processing variables.
- Modify the design of the processing equipment to achieve an efficient processing.

UNIT I  RHEOLOGY OF POLYMER SYSTEMS  9
Flow behavior-viscosity, Newtonian and non-Newtonian behavior, capillary and rotational viscometers, flow curve, mathematical approximation of flow behavior, curing behavior, rheometry

UNIT II  COMPOUNDING AND MIXING PROCESS  9
Rubber mixing mechanism - mixing machinery - two roll mill - internal mixer–machine design & operation - Simulation of flow - mixing in internal mixers & two roll mill, mixing cycles and procedures, operating variables and mix quality.

UNIT III  FORMING OPERATIONS  9
Rubber extrusion - single screw extruders - types, extruder screws designs-simulation and flow mechanism through dies, process optimization, extrudate defects; Calendaring of rubber, roll configurations, process simulation & flow analysis and troubleshooting; Latex Processing.

UNIT IV  MOLDING AND VULCANIZATION  9
Compression, transfer and injection molding of rubbers, moulds, process optimization, simulation and flow analysis of molding process; vulcanization processes - batch processes. Continuous vulcanization – machinery & process - Reaction injection molding of PU; silicone injection molding.

UNIT V  MANUFACTURE OF RUBBER PRODUCTS  9
Materials, machinery, mould, dies and process optimization for the manufacture of rubber products-Tyre, tube, hose, belts, cables, sports goods, footwear, molded and rubber to metal bonded products.

TOTAL : 45 PERIODS

REFERENCES

OBJECTIVE

- To give an exposure in using Software tools for new product development, mould designing and to perform Analysis.

OUTCOMES

By the end of this course, students will be able to

- To impart knowledge on CAD and CAE.
- To able to understand mould design and drawing.
- To be able to apply CAD in real life Applications
- To perform simulation and analysis using software tools.
- To impart knowledge of non linear material Analysis.

Introduction to mould, Dies & production drawing - classification of drawing - BIS conventions. Reviews of the concepts of limits, tolerance, fits, surface roughness, and symbols terminology used in Production drawing.

LIST OF EXPERIMENTS

I. DESIGN AND DRAWING OF MOULDS

1. Hand Mould, Semi – Injection Mould
2. Multi Cavity – Multiday Light Mould
3. Side Core ,Collapsible core - Mechanism

II. DESIGN AND DRAWING OF DIES

1. Hot and Cold Extrusions
2. Extrusion of Tubes and profiles

III. ANALYSIS OF INJECTION MOULDING OF SIMPLE PRODUCTS USING MOULD ANALYSIS SOFTWARES


IV. ANALYSIS OF SIMPLE PRODUCTS USING SOFTWARES

a. O-rings
b. Seals
c. Dampers/springs
d. Rubber boot
e. Engine mount

TOTAL : 60 PERIODS

[Signature]
DIRECTOR
OBJECTIVES
- To impart the knowledge of various characterizations methods.
- To understand the importance of characterization techniques.

OUTCOMES
By the end of this course, students will be able to
- Select suitable characterization techniques to characterize the given compound.
- Interpret and analyze the given data of any compound.

UNIT I REVIEW ON CHARACTERIZATION METHODS

UNIT II THERMAL ANALYSIS

UNIT III MOLECULAR WEIGHT STUDIES

UNIT IV SPECTROSCOPY

UNIT V MORPHOLOGY

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES

- To introduce the rubber compounding ingredients, their importance and technical classification of rubber mixes.
- To estimate the compound cost.
- To study the quality related concepts.
- To understand the compound design requirement of various rubber products.

OUTCOME

By the end of this course, students will be able to

- Understand the line call out and analyse the compound design.
- Design a cost effective formulation for a specific product requirement.
- Maintain and improve the quality of the product consistently

UNIT I  RUBBER ADDITIVES  12

Need for compounding - Vulcanising agents – sulphur, peroxides, phenolic resins, metal oxides, amines, urethane cure, etc - accelerators – activators- PVI, retarders, coagents etc. Fillers – carbon black-their preparation, reinforcement mechanism, characteristics, non- black fillers, anti oxidants and anti ozonants, colorants, processing aids – reclaimed rubbers

UNIT II  DESIGN FOR PROCESS, PERFORMANCE AND ECONOMICS  8

Line call out - Compound cost calculations- Compounding approach to cost control (black, non-black, polymer substitution), productivity- process and vulcanization – experimental design in compound development - DoE

UNIT III  DESIGNING COMPOUNDS FOR VARIOUS RUBBERS  12


UNIT IV  QUALITY CONTROL AND THE MIXING PROCESS  5

Raw material check - elastomers- fillers and other additives-bin storage problems - SPC charting, rheograph data- its meaning and application, DOE,Taguchi method

UNIT V  COMPOUND DEVELOPMENT FOR A FEW NON TYRE PRODUCTS  8

coolant hoses, fuel hoses, v belts, v ribbed belts, conveyor belts, compound design for load bearing and vibration control - engine mounts, diaphragms, and bearings.

REFERENCES

OBJECTIVES
- To impart the knowledge on design factor involved in a rubber product manufacture.
- To understand the behavior of rubber product under different loading conditions.

OUTCOME
By the end of this course, students will be able to
- Demonstrate the ability to design and conduct experiments, as well as to analyze and interpret data for different rubber products

UNIT I      SIMPLE GEOMETRIES  9
Spring Rates - Creep – Stress relaxation – Rubber Products in compression –  Design of simple Geometries – Rubber Blocks – Rubber bonded assemblies Design to specific spring rates

UNIT II     RUBBER UNDER COMPLEX LOADING  9

UNIT III    RUBBER PRODUCTS UNDER DYNAMIC CONDITIONS  9

UNIT IV     RUBBERS IN SEALING APPLICATIONS  9

UNIT V      MOULD AND DIE DESIGN  9
Design of Moulds & Dies for Rubber products – Compression Moulds -Transfer Moulds- Injection Moulds - Designing rubber products for specialty applications

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To impart interest and sense of appreciation of all about pneumatic tyre,
- To educate the students in respect of tyre performance as a function of size, carcass design, reinforcement and rubber materials.
- To reiterate the role of various forces and moments as variables to tyre performance and life.
- To capture the features of tread design and materials as related to grip, life and safety,
- To provide insight to the test design, tyre properties, tire retreading and related end of life cycle.

OUTCOMES
By the end of this course, students will be able to
- To appreciate the role of rubber materials and particularly general purpose rubbers shaping into a high performance pneumatic tyre,
- To understand various carcass materials and methods in tyre reinforcement,
- To visualize various tread design and its role in grip, life and safety,
- To relate to automobiles like 2 wheeler, 4 wheeler (LT, HDT, PC) and OTR in terms of the design variations relating to tyre performance,
- To understand the fundamental design differences among these end use dependent tyre sizes, tubed and tubeless tyres.

UNIT I  TYRE COMPONENTS AND STRUCTURE
9

UNIT II  TYRE CORD REINFORCEMENTS
9

UNIT III  TYRE COMPONENT DESIGN BASICS
9

UNIT IV  TYRE AND TUBE MANUFACTURING
9

UNIT V  TYRE PERFORMANCE AND TESTING
9
Tyre Mechanics – Forces acting on Tyres – Lateral, Vertical and longitudinal forces, Steering properties-slip angle, Aligning Torque, Static steering Torque. Road Contact Pressure, Traction, Power loss, Friction, Rolling Resistance, Noise and Vibration, Tread Wear, Fatigue and separation, Heat Build up, Bruise, Cutting, Cracking and Tearing.
Tyre Testing – Destructive and Non-destructive Testing of Tyres, Plunger Tests (Breaking energy), Pulley wheel test Field Tract Testing – Braking, Acceleration, mileage, Regulations, Tyre Labelling.

TOTAL : 45 PERIODS

REFERENCES

RT7211 RUBBER PROCESSING AND TESTING LAB

OBJECTIVES
- To enhance the skills of the students to design and prepare different rubber compound.
- To study the curing characteristics of the compound.
- To evaluate the basic mechanical properties of the prepared rubber compound.

OUTCOMES
By the end of this course, students will be able to
- Operate and analyze the problems in various rubber processing equipments.
- Optimize the curing parameters to suit the productivity.
- Prepare the specimens as per the standard to assess its mechanical and other relevant properties

LIST OF EXPERIMENTS
1. Rubber Mixing (4 Exp)
   Mastication of natural rubber and mixing of rubber (gum and filled compounds) using two-roll mixing mill and Kneader.
2. Vulcanization studies using ODR (1 Exp)
3. Rubber Extrusion (1 Exp)
   Processing of Rubber compounds on an rubber extruder, die, extrudate defects
4. Moulding of Rubber Compounds (2 Exp)
   1. Study on construction, operation and molding of rubber compound on a hydraulic press.
   2. Study on optimizing the curing parameters
5. Latex Compounding (2 Exp)
   1. Preparation of dispersion in a ball mill
2. Preparation of compounded latex.

6. 1. Mechanical Testing, Abrasion test, Compression set test
    2. Swelling Tests-Cross-link density measurements, Viscosity-solution

(6 Exp)

TOTAL : 60 PERIODS

RT7001  ADHESIVES AND ADHESION TECHNOLOGY  L T P C
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OBJECTIVES
- To impart the fundamentals on adhesives and adhesion process.
- To know about the properties and applications of various adhesives and its joining mechanism

OUTCOME
By the end of this course, students will be able to
- Understand the selection of adhesives and adhesion process and its applications

UNIT I  FUNDAMENTALS OF ADHESION  10
Adhesives –importance – theories of adhesion -types of substrates –mechanisms of setting, adhesive strength – thermodynamics of adhesives – concepts of surface energy, contact angle etc - types of joints – joint selection –testing of adhesive joints

UNIT II  SURFACE PREPARATION  9

UNIT III  NON REACTIVE ADHESIVES  12

UNIT IV  REACTIVE ADHESIVES  7
Phenolics, epoxies, acrylics, anaerobics, cyanoacrylates – poly imides-bis maleimide and other high temperature adhesives-properties and applications

UNIT V  ADHESION IN RUBBER PRODUCT MANUFACTURE  7
Rubber to metal bonding – rubber to fabric bonding – bonding systems available for manufacture of rubber to metal and rubber to fabric bonded products.

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES

- To impart the fundamentals of biopolymer and biocomposites.
- To know about the manufacture, properties and applications of various biopolymer, biofiber/filler and their composites.

OUTCOME

By the end of this course, students will be able to

- Understand the concepts of biopolymer blends and biocomposites, properties, biodegradability and applications

Demonstrate the ability to select a suitable biopolymer and its reinforcement to meet desired needs within realistic constraints

UNIT I  BIOPOLYMERS  8
Introduction – Classification - Biopolymers from natural origin and mineral origin - isolation – properties.

UNIT II  BIODEGRADATION  10
Biodegradation.- Mechanism of biodegradation (polyesters, polycarbonates, polyvinyl alcohol, polyurethanes and polyethers) factors influencing biodegradation. Types of biodegradable polymers – properties and application.

UNIT III  CHARACTERIZATION AND TESTING FOR BIODEGRADABILITY  9

UNIT IV  BIOCOMPOSITES  9
Definition- classification- natural bio - fibre and nano fillers as reinforcement, biodegradable/ biobased resins as matrices. Properties of biocomposites. Applications in automobile & buildings.

UNIT V  APPLICATIONS OF BIOPOLYMER  9

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To have an exposure on various concepts in Computer Aided Design.
- To know about recent advances in computer based design.
- To impart knowledge on various product modeling concepts.

OUTCOME
By the end of this course, students will be able to
- Understand the various product design concepts and tools.
- Design, formulate, interpret and analyse data using CAD tools and software.
- Use modern engineering tools and solve the problems.

UNIT I  INTRODUCTION TO COMPUTER AIDED DESIGN  8

UNIT II  PRODUCT MODELLING  8

UNIT III  PRODUCT DESIGN CONCEPTS  10

UNIT IV  PRODUCT DESIGN TOOLS AND STANDARDS  10

UNIT V  POLYMER PRODUCT DESIGN  9

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES

- To impart the knowledge on Numerical Methods in solving the problems using Finite Element techniques.
- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To understand the behaviour of rubber product under different loading conditions.

OUTCOMES

By the end of this course, students will be able to

- Demonstrate the ability to FEM to a range of Engineering Problems.
- Use the modern engineering tools and analyze the problems within the domains of rubber and plastics as the members of multidisciplinary teams.

UNIT I INTRODUCTION


UNIT II DISCRETE ELEMENTS

Use of bar and beam elements in structural analysis – Bar of varying section – Temperature effects.

UNIT III CONTINUUM ELEMENTS


UNIT IV ISOPARAMETRIC ELEMENTS

Definition and use of different forms of 2-D and 3-Elements–Formulation of element stiffness matrix – Load vector

UNIT V NON LINEAR SOLUTION SCHEMES

Different methods of solution of simultaneous equations governing static, dynamics and stability problems. Elastomers - Elastic material model correlation-Terminology-Types of FEA models-Model building- Non linear material behavior- Boundary conditions-Applications- Software packages

TOTAL : 45 PERIODS

TEXT BOOKS


REFERENCES

OBJECTIVES

- To impart the fundamental concepts of heat and mass transfer.
- To understand the impact of heat transfer in rubber processing.

OUTCOME

By the end of this course, students will be able to

- Understand the basics of heat and mass transfer mechanism.
- Demonstrate the ability to apply the principle of heat and mass transfer in rubber processing

UNIT I  HEAT TRANSFER  10


UNIT II  HEAT TRANSFER COEFFICIENTS  12

Individual and overall – coefficients for forced convection in tubes and around submerged objects, for free convection, film type condensation and boiling liquids – thermal radiation – radiation between surfaces, from gases – temperature measurement – from radiation – Design and analysis of heat transfer equipment

UNIT III  MASS TRANSFER  8

Mass transfer – molecular and Eddy diffusion – steady state diffusion under stagnant and laminar flow conditions – diffusivity measurement and prediction

UNIT IV  CONCEPT OF MASS TRANSFER COEFFICIENT  10

Overall mass transfer coefficients – additivity equation in terms of individual phase coefficients – \( j_0 \) factor – HTU and NTU concepts – equilibrium and operating line concepts in mass transfer calculation. Diffusion of gases and vapours in polymer melts.

UNIT V  HEAT TRANSFER IN RUBBER PROCESSING  5

Heat transfer in Rubber Injection Moulding process – Heat transfer in other continuous Vulcanization techniques.

TOTAL : 45 PERIODS

REFERENCES

OBJECTIVES
- To understand the characteristics of latex, its classification and source.
- To impart the fundamentals of latex compounding and processing.
- To study about the manufacture, properties and applications of synthetic latex.

OUTCOMES
By the end of this course, students will be able to
- Differentiate the behaviour of latex from dry rubber in terms of stability, compounding and processing.
- Understand the principle behind latex product manufacture.
- Demonstrate the ability to design a formulation and select a suitable process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

UNIT I  LATEX—NATURE AND CHARACTERISTICS  9
General nature and characteristics of latex, classification of latex, comparison of polymer lattices and polymer solutions, colloidal stability and destabilization of lattices, flow properties of latex.

UNIT II  COMPOUNDING OF LATEX  9
Natural rubber latex tapping-chemical composition – preservation- concentration – stabilization - quality control test - Compounding of latex - selection of compounding ingredients & formulation design- maturation -prevulcanized and chemically modified latex.

UNIT III  PROCESSING OF LATEX  9
Dipping process, types of dipping, dipping plant design, formers, process control; Foaming, extrusion, spraying and casting-process control; leaching, sterilization, chlorination, deproteinization. Manufacture and formulation of latex products- condom, gloves, balloons, catheters; Foam rubber, thread, tubing, toys

UNIT IV  SYNTHETIC LATEX  9
Synthetic latex, manufacture, properties and application- SBR, NBR, CR, Vinyl ester polymers, acrylic polymer, ethylene-vinyl chloride copolymer, polybutadiene and synthetic isoprene: Specialty lattices-PVDC, PAN, polyvinylpyridine, butyl, fluoro polymer, and CSM latex.

UNIT V  APPLICATIONS OF LATEX  9
Medical, Building and construction, Textiles and Non-woven fabrics, surface coatings, paper, inks, leather, adhesives and sealants.

TOTAL : 45 PERIODS

REFERENCES
1. D.C.Blackely,”Polymer Lattices”, Vol 1,2 & 3.
2. H.Warson and C.A.Finch, Applications of synthetic Resin latices, Vol.1,2,3, John Wiley & Sons Ltd. 2001
OBJECTIVES
- To understand the concept of Mold and Die design and its manufacturing techniques.
- To introduce recent trends in mould manufacturing.

OUTCOMES
By the end of this course, students will be able to
- Implement the various concept of Mould design.
- Apply CAD in Mould design and Analysis
- Study any mould design and drawing.

UNIT I CONCEPTS IN MOULD ENGINEERING AND MOULD DRAWING 8

UNIT II COMPRESSION, TRANSFER AND BLOW MOULD DESIGN 10
Types of compression moulds - clamping pressure - pressure pads - depth of loading chamber - heating systems - types of heaters - calculation of heat requirement and heater capacity - Types of transfer moulds - clamping pressure - transfer pot design - Types of blow moulds - blow ratio – blow pin and neck ring design - clamping force.

UNIT III DESIGN OF INJECTION MOULDS 12

UNIT IV EXTRUSION DIE DESIGN 7
Extrusion die design - process characteristics of polymer melt - die geometry - Mechanical design of extrusion dies - Extrusion dies for elastomers.

UNIT V RECENT TRENDS IN MOULD MANUFACTURING 8

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To study the mechanical behaviour of plastics.
- To introduce the different compounding, mixing and processing techniques for plastics.

OUTCOMES
By the end of this course, students will be able to
- Able to compound and mix plastics and prepare plastics compound as per the required properties.
- Decide the processing parameters for a specific plastics product within realistic constraints.
- Solve the product defect due to rheological behavior and processing variables.
- Modify the design of the processing equipment to achieve an efficient processing.

UNIT I PROPERTIES OF PLASTICS 9

UNIT II CONTINUOUS PROCESSING OF PLASTICS 9

UNIT III INJECTION MOULDING OF PLASTICS 9
Basic principles – Classification of processing methods – Effect of polymer properties on processing behavior: Injection Moulding – Definition of terms – Specification – Types of machines used – Part & their functions – Cycle time – Process variables & its effect on Moulding quality – Cavity pressure profile – Factor influencing moulding shrinkage, annealing – Frozen-in – Stresses – Types of clamping systems and their merits & demerits – Start up and shut down procedures – Processing parameters and special precaution to be taken while processing of Engineering plastics such as Nylon, Acetal, PC, etc., - Common moulding defects, causes and remedies.

UNIT IV BLOW MOULDING, ROTATIONAL MOULDING, COMPRESSION AND TRANSFER MOULDING PROCESS 9
Blow moulding, rotational moulding, compression & transfer moulding, thermoforming- materials, mould, process optimization, flow simulation and troubleshooting; Joining and machining of plastics.

UNIT V COMPOUNDING AND MIXING OF POLYMERS 9
Principles of plastics compounding – additives - pre-compounding operations, machinery, post compounding operations, compounding for specific properties.

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES

- To impart the fundamentals of polymer blends and alloys.
- To know about the manufacture, properties and applications of various TPE and their blends.

OUTCOME

By the end of this course, students will be able to
- Understand the concepts of polymer blends and alloys.
  Demonstrate the ability to select a suitable blend to meet desired needs within realistic constraints

UNIT I  INTRODUCTION
Need for Polymer blends – Thermodynamics of polymer solutions – Binary systems – thermodynamics of polymer blends – Criteria for miscibility – Compatible and incompatible polymer blends – Polymer Alloys

UNIT II  BLOCK COPOLYMERS AS COMPATIBILIZERS
Need for Compatibilizers – Science and Technology of Compatibilization-Morphology development in compatibilized blends – Morphology development during processing – Blends of Thermoplastics such as PE, PP, polyesters, polyamides, polycarbonates, ABS – processing – structure-property relationships – morphology and properties - applications

UNIT III  BLOCK COPOLYMERS

UNIT IV  THERMOPLASTIC ELASTOMERS
Styrenic TPE’s- Thermoplastic Polyurethanes -Thermoplastic Copolyesters-Ethylene-co-vinyl acetate polymers - Ethylene Propylene rubbers -Preparation, Structure-property relationships and applications.

UNIT V  BLENDS OF TPE

TOTAL : 45 PERIODS

REFERENCES
2. M.A.Wheelans, Developments in Rubber Technology, Vol.3
OBJECTIVES
- To impart the fundamentals of polymer composites and structures
- To know about the manufacture, properties and applications of various FRP.

OUTCOME
By the end of this course, students will be able to
- Understand the concepts of polymer composites and mechanics of composites.
- Demonstrate the ability to select a suitable polymer and fiber to meet desired needs within realistic constraints and processing techniques.

UNIT I COMPOSITE MATERIALS
Polymer composite materials, classification and theory of composite materials; Polymer matrices - thermoplastics and thermosetting plastics; Fiber reinforcement of elastomers - short and long fiber composites – Other additives

UNIT II MECHANICS OF COMPOSITES
Fiber orientation; Hooke’s law for orthotropic and anisotropic materials; micromechanics and macromechanics of lamina; Lamina stress-strain relations referred and principal material directions and arbitrary axes.

UNIT III ANALYSIS OF LAMINATED COMPOSITES
Governing equations for anisotropic and orthotropic plates-Angle-ply and cross ply laminates; Static, dynamic and stability analysis for simpler cases of composite plates; interlaminar stresses, failure and fracture analysis.

UNIT IV DESIGNING OF FRP
Design of FRP products - pipe, boat, wind mill blade, storage tanks, automotive drive shafts, leaf spring etc; Joining and repairing of FRP;Quality control test and non-destructive testing of FRP

UNIT V MANUFACTURING PROCESS
Hand lay up, spray up, resin transfer molding, vacuum bag and pressure bagmolding; centrifugal-casting, pulltrusion, filament winding; compression, transfer and injection molding; Sandwich construction and Foam reservoir molding.

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES

- To impart the fundamentals of nanofiller and polymer nanocomposites
- To know about the manufacture, properties and applications of various nanofillers and polymer nanocomposites

OUTCOME

By the end of this course, students will be able to

- Understand the concepts in selecting nano fillers and its incorporation in polymer matrix

UNIT I          POLYMERS IN NANOSYNTHESIS

Template - Directed Assembly - Block copolymers and their phase behavior - Directed assembly of polymer blends - Assembly and transfer of nanoparticles/ nanofibers using polymers, Structural control at the nanoscale.

UNIT II         NANOMATERIALS USED IN POLYMERS

Nanofillers in bulk polymers - overview of potential nanostructured fillers - types - nanoparticles, nanofibers, nanotubes, nanosheets; surface features and layers and its modification. Techniques used to characterize nanostructured materials – XRD, AFM, etc.

UNIT III        CARBON NANOTUBES AND THEIR APPLICATION

Structure of carbon nanotubes, processing methods for nanotube based polymer nanocomposites, nanotube alignment, characterization, properties and applications.

UNIT IV         PREPARATION AND PROCESSING OF POLYMER NANOCOMPOSITE

Preparations of polymer nanocomposites - melt blending, solution blending, latex coagulation, in-situ polymerization, characterization, properties and application.

UNIT V          APPLICATION OF POLYMER NANOCOMPOSITES

Polymers in nanoelectronics, Magnetic polymer nanocomposites, Wear resisting polymer nanocomposites, Packaging, Bio-medical, surface coatings, etc.

TOTAL : 45 PERIODS

REFERENCES

OBJECTIVES
- To impart knowledge on the kinetics related to polymerization.
- To study about the fundamentals of reactor design.

OUTCOME
By the end of this course, students will be able to
- Understand the principle behind reactor design and polymer kinetics.
- Design a reactor for a particular process.

UNIT I ELEMENTS OF CHEMICAL REACTION ENGINEERING
Introduction to chemical kinetics - Representation of expression for reaction rate, Temperature dependent and concentration dependent - Interpretation of Batch Reactor data for various types of reactions taking place in constant volume and variable volume batch reactors.

UNIT II REACTOR DESIGN

UNIT III HEAT EFFECTS IN REACTORS
Isothermal and non isothermal homogenous system – adiabatic reactors – rates of heat exchange for different reactors – design for constant rate heat impact and constant heat transfer coefficient operations – batch and continuous reactors conversions – equilibrium – non-ideal flow in reactors

UNIT IV POLYMERISATION REACTORS

UNIT V MODELS OF HETEROGENEOUS POLYMERIZATIONS
Solution / precipitation, suspension and Emulsion polymerization - Smith Ewart Model Application to continuous emulsion polymerization - Co-ordination polymerization in fluidized bed reactor – Design - fundamentals of reactors for tailor making polymers example metallocene polyolefins - Qualitative account of control engineering considerations in operation of batch and continuous polymerization process

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES
- To realize the importance of testing at different stages while converting a raw material into a desired product.
- To introduce various testing methods for raw materials, rubber compound and its product.

OUTCOME
By the end of this course, students will be able to
- Select a suitable testing method to check the various quality aspects. Use advanced engineering tools and analyzes the problems within the domains of rubber and plastic

UNIT I TESTING IN PERSPECTIVE
Quality systems- assurance and management, standards and specifications, Statistical analysis of test data, polymer sample preparation and conditioning.

UNIT II TESTS FOR PROCESSABILITY
Viscosity - flow characteristics – Melt Flow Index, Gel Permeation Chromatography - tests for thermosets - spiral flow - bulk factor - Gelation and gel time.

UNIT III TESTS FOR MECHANICAL PROPERTIES
Hardness, Stress – strain properties – Permenant set, creep and stress relaxation, impact properties – Flexural properties.

UNIT IV TESTS FOR DURABILITY
Abrasion, fatigue, S-N Curves - Crack growth-low temperature and high temperature properties, accelerated aging, Failure and Fracture analysis, reverse engineering

UNIT V TESTS FOR SPECIFIC PROPERTIES
Media tests - solvent, and gas permeability, optical, flammability, electrical and testing of finished products and non destructive tests etc.

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To know the various recycling methods of polymers.
- To impart knowledge on degradation of polymers.

OUTCOMES
By the end of this course, students will be able to
- Understand the professional and ethical responsibility to solve the environmental issues related to polymers.
- Demonstrate the necessity to develop new material, design, process, testing and solution for environmental related problems related to their field.

UNIT I  SOURCE SEGREGATION AND SORTING  9

UNIT II  DEGRADATION TECHNIQUES  7
Polymer degradation techniques – types of degradation – thermal – oxidative – photo – mechanical – biodegradation – process technology for biodegradable polymers

UNIT III  PLASTICS RECYCLING  11
Recycling of thermoplastics - Polyolefins - PVC, PET, Polystyrene, Nylon, Polyurethanes, polyacetals-mechanical process and chemical process - applications of recycled materials. - Recycling of thermosets and polymer composites - applications of recycled materials

UNIT IV  RUBBER RECYCLING  9
Recycling of used tyres and other rubber products – conventional methods – mechanochemical processing – ultrasonic devulcanization – thermomechanical means – recycling cross linked networks via high pressure, high temperature sintering - conversion of tyres to carbon black and oil

UNIT V  CLOSED LOOP RECYCLING  9

REFERENCES

TOTAL : 45 PERIODS
OBJECTIVES
- To study the electrical behaviour of polymers
- To study the conduction mechanism of polymers and its application

OUTCOMES
By the end of this course, students will be able to
- Able to select the polymers for electrical and electronic applications
- Able to test the electrical properties of polymers

UNIT I INTRODUCTION TO POLYMERS
Structure of polymers- saturated and unsaturated polymers, Effect of polymer structure on electrical properties- Chemical and physical variant, conformation and hindered rotation, copolymers, crystallization and orientation, Polymers as non-conductive and conductive materials.

UNIT II DIELECTRICS IN STATIC FIELDS
Electrostatic relation, molecular polarisability local field Clausius-Mosotti relation, relative permittivity of polymer, dielectric relaxation in solid polymers, polymer liquids.

UNIT III MECHANISM OF CONDUCTION
Theories of electronic conduction - Band theory of conduction, properties of semi conductors, hopping conduction, metal insulator transition, band theory applied to polymers, super conduction, and ionic conduction-polyelectrolyte’s and protonic conductors, solid polymer electrolytes, ionic impurities and antistatic agent.

UNIT IV MEASUREMENT OF DIELECTRIC PROPERTIES
Introduction, Bridge methods, Resonance methods, Wave transmission methods, Time – domain methods.

UNIT V APPLICATIONS OF ELECTRO-ACTIVE AND CONDUCTIVE POLYMERS
Electro-active polymers – xerography, OLEDs and Solar cells, Non-linear optics, intrinsically conductive polymers – soft electronics, LEDs, Photovoltaic devices, Sensors, Electrochemical applications, conductive coatings and composites and other applications.

TOTAL : 45 PERIODS

REFERENCES
3. Polymers for electronic and photonc applications, I.Bowden

OBJECTIVES
- To impart the knowledge on research design
- To know about the data processing, report writing and Intellectual property rights

OUTCOME
By the end of this course, students will be able to
- Understand the concepts of various approaches of research, literature survey methods, data analysis, report preparation and significance of Intellectual property Rights
UNIT I   INTRODUCTION TO RESEARCH  7
Research – Objective – Significance – Types – approaches; Research and scientific research –
The hall marks of scientific research; Research process – steps involved; Current literature
survey methods – abstraction of research papers –

UNIT II  RESEARCH DESIGN AND SAMPLE DESIGN  10
Research Design – Need for Research Design – steps involved - features of Good Design –
Important concepts relating to Research Design – Different Research designs – Basic Principles
of Experimental Designs – Sample Design – steps involved – sampling techniques – Hypothesis
testing to determine optimal sample size.

UNIT III  ANALYSIS OF DATA  9
of Asymmetry (Skewness) – Measures of Relationship – Simple Regression Analysis – Multiple
Correlation and Regression Partial Correlation – Association in case of attributes – Other
Measures – Summary chart concerning Analysis of Data.

UNIT IV  INTERPRETATION AND REPORT WRITING  9
Interpretation – need for interpretation - Technique of interpretation – precaution in
Layout of the Research report – Types of reports – Oral presentation – Mechanics of writing
Research Reports.

UNIT V   INTELLECTUAL PROPERTY RIGHTS  10
An overview of Intellectual property (IP) – Importance – Protection of IPR – Patents –
Patentable and Non-Patentable inventions – Procedure for filing of patents – acquisition of
patent rights – patents offices in India and jurisdiction – Modification of granted patents –
protection against unfair competition – Enforcement of IPR.

TOTAL : 45 PERIODS

REFERENCES
   2000.

RT7017  SPECIALTY POLYMERS  L T P C
            3 0 0 3

OBJECTIVES
• To understand the fundamental behaviour of non Newtonian fluids.
• To introduce the properties and applications of engineering thermoplastics, thermosets
  and other strategic polymer materials.

OUTCOMES
By the end of this course, students will be able to
• Select an appropriate polymer for the required application.
• Demonstrate the necessity for new material development to replace the existing one.
UNIT I  TECHNOLOGY OF NON-NEWTONIAN FLUIDS  9
Characteristics – properties – specific cases – Plastisols, Organosols, PVC pastes, slurries etc.
- processing – properties - applications

UNIT II  POLYELECTROLYTES AND COATING MATERIALS  9
Polyelectrolytes – Polymer electrolyte membranes- ionomers –polymer microgels – polymer
colloids -emulsion paints – adhesives - types – properties – industrial applications –
coatings – surface preparation – types – properties - applications

UNIT III  ENGINEERING THERMOPLASTICS  9
Thermoplastics – UHMWPE, Polyacetsals, ABS, PBT, PEI, PPE, PEEK –
Thermoplastic polyimides, liquid crystal polymers, polyamide – imide, polyarylethesulphones, polycarbonates,
PPS – polybenzimidazoles

UNIT IV  THERMOSETS  9
Unsaturated polyesters – vinylesters – epoxy resins – cyanate esters – isocyanate polymers
– BMI’s – PMR resins – benzocyclobutene resins – silicones

UNIT V  STRATEGIC MATERIALS  9
Conducting polymers – electroluminescent polymers - photoconducting polymers – polymers in
optoelectronics - polymers with piezoelectric, pyroelectric & ferroelectric properties –
biomedical applications – IPN’s.-Polymers in space applications - Propellent binders-Insulation
lining etc.

TOTAL : 45 PERIODS

REFERENCES

RT7018  STRESS ANALYSIS OF POLYMERS  L T P C
3 0 0 3

OBJECTIVES
- To understand the stress strain behavior in polymers.
- To impart knowledge on analysis of different beams.
- To educate students on fracture mechanics in polymers.

OUTCOMES
By the end of this course, students will be able to
- Understand the various design aspects to be considered for manufacturing the products.
- Utilize the stress strain mechanism while designing and manufacturing.

UNIT I  ANALYSIS OF STRESS AND STRAIN  9
Analysis of stress at point and plane – principal stress – hydrostatic stress, stress at adjacent
points and the equilibrium equations – strain in two dimensions – strain energy – yield criteria.

UNIT II  TIME DEPENDENT BEHAVIOUR  9
Creep – Visco Elastic Theory – Linear Visco Elastic materials and models - Maxwell - Voigt
models - Power law materials
UNIT III BENDING AND TORSION

UNIT IV STRESS FUNCTIONS
Stress functions in Cartesian coordinates – Axial symmetry – Stresses around a circular hole – Stresses around crack tips

UNIT V FRACTURE MECHANICS
Energy release rates (G&K)– The relationship between G and K – Solutions for K in some cases like elliptical hole, uniformly loaded sheet – Cracks in three dimensions – Fracture criteria and crack propagation – Blunt cracks and notches

TOTAL : 45 PERIODS

REFERENCES

RT7019 THEORY OF VISCOELASTICITY L T P C 3 0 0 3

OBJECTIVES
- To know the fundamentals of viscoelastic behaviour of a polymer.
- To understand the effect of various parameters like temperature, time etc on viscoelasticity.
- To impart an idea about the relation between viscoelasticity and microstructure.
- To know about the various experimental studies about viscoelastic behaviour of polymer.

OUTCOMES
By the end of this course, students will be able to
- Predict the melt behaviour.
- Adapt a suitable method to study about the rheological behaviour and properties while processing the compound.
- Correlate and fix the external parameter to achieve desirable flow behaviour.

UNIT I INTRODUCTION TO VISCOELASTICITY
Nature of viscoelastic behaviour – Molecular mechanisms – phenomenological aspects
Illustrations – Interrelations among viscoelastic functions – viscoelastic liquids – soft viscoelastic solids.

UNIT II TIME, TEMPERATURE EFFECTS ON VISCOELASTICITY
UNIT III VISCOELASTICITY AND LONG TERM DEFORMATION
Viscoelasticity in bulk deformation – Maxwell and Voight models – Standard linear model - Four parameter model - Boltzmann superposition principle - Applications to practical problems.

UNIT IV VISCOELASTICITY AND MICROSTRUCTURE
Viscoelasticity in amorphous and semicrystalline states – Polymer solutions and gels - Rheological properties of polymer melts - Flow analysis and measurements.

UNIT V MEASUREMENT OF VISCOELASTICITY

TOTAL : 45 PERIODS

REFERENCES

AL7017 THEORY OF VIBRATIONS

OBJECTIVE
- To study the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS

UNIT II MULTI-DEGREES OF FREEDOM SYSTEMS
Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton’s Principle, Lagrangean equation and their applications.

UNIT III VIBRATION OF ELASTIC BODIES

UNIT IV EIGEN VALUE PROBLEMS & DYNAMIC RESPONSE OF LARGE SYSTEMS

UNIT V ELEMENTS OF AEROELASTICITY
Aeroelastic problems – Collar’s triangle of forces – Wing divergence – Aileron control reversal – Flutter.

TOTAL : 45 PERIODS
TEXT BOOKS

REFERENCES

AM7251 VEHICLE DYNAMICS L T P C
3 0 0 3

UNIT I BASIS OF VIBRATION

UNIT II TYRES

UNIT III VERTICAL DYNAMICS

UNIT IV LONGITUDINAL DYNAMICS AND CONTROL

UNIT V LATERAL DYNAMICS

TOTAL : 45 PERIODS

TEXT BOOKS
REFERENCES
1. Dean Karnopp, Vehicle Stability, 1st edition, Marcel Dekker, 2004

MN7151 MATERIALS TECHNOLOGY L T P C

AIM
To impart knowledge on the advanced concepts of material technology

OBJECTIVES
- To make the students to understand on elastic, plastic and fractured behaviour of engineering materials.
- To train the students in selection of metallic and non-metallic materials for the various engineering applications.

UNIT I ELASTIC AND PLASTIC BEHAVIOR 10
Elasticity in metals and polymers – Anelastic and visco-elastic behaviour – Mechanism of plastic deformation and non metallic shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of non crystalline materials.

UNIT II FRACTURE BEHAVIOUR 10

UNIT III SELECTION OF MATERIALS 10
Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8

UNIT V NON METALLIC MATERIALS 7
Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers.
Advanced structural ceramics, WC, TiC, TaC, Al₂O₃, SiC, Si₃N₄ CBN and diamond – properties, processing and applications.

TOTAL : 45 PERIODS

REFERENCES

MS 7151 MANUFACTURING MANAGEMENT L T P C 3 0 0 3

OBJECTIVE
To understand the fundamentals concepts of operations management in a manufacturing and service sectors.

OUTCOME
The students will have knowledge in layout planning, forecasting, production planning, inventory control, maintenance system and effective utilization of resources in manufacturing system.

UNIT I FACILITY, CAPACITY & LAYOUT PLANNING 9
Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even, Load distance model, closeness ratings.
Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP.
Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT II DEMAND FORECASTING & PROJECT MANAGEMENT 10
Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, numerical problems, Long term forecast methodologies.
Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques, Analyzing cost-time trade-offs – Case study.

UNIT III PRODUCTION PLANNING & CONTROL 9

UNIT IV INVENTORY PLANNING & CONTROL 8
EOQ models- with and without shortages, price breaks, effect of quantity discount – selective inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, kanban, Zero inventory – Case study.
UNIT V MAINTENANCE SYSTEM

Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines, Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period, spares management. Maintenance records.

TOTAL: 45 PERIODS

REFERENCES