

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-501

Course Title: Polymeric Materials and their Properties

L-T-P: 2-0-0

Credits: 2

Subject Area: PCC

Course Outlines: Basic of Polymers; Morphology of Polymers; Polymer Structure; Mechanical and Chemical Properties of polymers; Polyolefins; Thermoplastics: Vinyl chloride polymers, Fluorine-containing polymers, Poly (vinyl acetate) and its derivatives, Acrylic plastics, Plastics based on styrene. Engineering Thermoplastics: Polyamides and polyimides, Polyesters, Polycarbonates; Thermosetting Polymers: Epoxy, Thermosetting polyester and Phenolic resins.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-503

Course Title: Polymer Rheology and Physics

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Introduction to Polymer Rheology and processing; Rheometry: Continuum Aspect of Rheology; Different Rheological Models; Constitutive Theories and Equations for Suspensions and rheology of complex polymeric fluid; General polymer chain models and associated physics; Models related to Chain Entanglement.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-505

Course Title: Macromolecular Chemistry

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Genesis and brief history of polymers, molecular weight of polymers along with their applications and determination, mechanism of chain and step polymerization, polymerization techniques and kinetics of polymerization, kinetics and chemistry of copolymerization, polymer reactions, polymers for engineering applications, and waste plastics recycling.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-511

Course Title: Polymer Synthesis, Processing and Characterization Lab

L-T-P: 0-0-6

Credits: 3

Subject Area: PCC

Course Outlines: Determination of T_g, T_m and T_c of semi-crystalline polymers with DSC, TGA analysis of degradation profile of polymers, study of mechanical stress vs strain behavior of polymers and impact strength of polymers; Rheology and dynamic mechanical analysis of polymeric materials with a Rheometer and DMA; Molecular weight analysis by GPC, synthesis of PMMA, PVA, Nylon 6,6 and their Study with UV-VIS IR, NMR and hot stage Polariscope, Determination of Molecular weight from solution state viscosity, identification of compounds with DSC, particle analysis with XRD, SEM, AFM and SLS.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-507

Course Title: Elastomer Technology and Processing

L-T-P: 2-0-0

Credits: 2

Subject Area: PCC

Course Outlines: Behavior of elastomers; effects of molecular weight and glass transition temperature; essential properties of specific diene and non-diene elastomers; Basic rubber compound and its vulcanization; engineering aspect of rubber product manufacturing; recent trends in rubber manufacturing technology.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PEC-509

Course Title: Advanced Polymer Characterization

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Elemental analysis, Spectroscopic characterization of Polymers, Thermal analysis: DSC & TGA, X-ray diffraction, Molecular weight determination, Optical Microscopic characterization, and Advanced Microscopic Characterization: SEM, TEM, and AFM.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Polymer and Process Engineering

Subject Code: PES-501

Course Title: Polymers for Society and Sustainability

L-T-P: 2-0-0

Credits: 2

Subject Area: SSC

Course Outlines: Polymer-integral to Sustainable Development, Bio-degradable polymer, Sustainability issues in polymer and society; Environmental footprint of polymer production; Issues of polymer waste and pollution; Innovations in green chemistry, Health risks associated with polymer chemicals, Medical plastics waste management, Polymers in sustainable water treatment and separations, Economic benefits and costs of polymers, Social implications and public perception, Polymers and resource conservation land, water, forest and energy, Integrated polymer waste management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-501

Course Title: Advanced Engineering Mathematics

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Analytical and numerical solutions of linear and non-linear algebraic equations, with applications in polymeric systems, heat transfer, mass transfer, and reaction engineering. Evaluation of various mathematical functions and their applications in polymer and process engineering. Numerical integration and differentiation, along with analytical and numerical solutions of ordinary and partial differential equations, and their wide-ranging applications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-502

Course Title: Applied Numerical Methods and AI

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Introduction to Numerical Methods and AI; Solution of Linear Equations; Solution of Non-linear Algebraic Equations; Evaluation of functions and interpolations; Ordinary Differential Equations and Initial and Boundary Value Problems; Examples of applications of AI, their advantages and limitations; Artificial Neural Network (ANN), Concepts of Optimization and techniques – Particle Swarm Optimization (PSO), Genetic algorithm (GA), African vultures optimization algorithm (AVOA), Supervised and unsupervised Machine learning.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-503

Course Title: Process Equipment Design

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Basic of Polymer Processing; Polymer Extrusion; Injection Molding; Compression Molding; Miscellaneous Processing Technologies: Blow Molding Technology, Resin Transfer Molding, Fiber Spinning, Polymer Foams, Transfer Molding, Rotational Molding, Thermoforming, Hand & Spray Layup, Calendaring, Filament Winding, Pultrusion; Tooling & Mold Design; Introduction, Classification, Design, and Accessories: Pressure Vessels, Shell-Tube Heat Exchanger, Condensers, and Storage Tanks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-504

Course Title: Advanced Optimization Techniques

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Key features of optimization problems, including classification and construction of optimization models. Coverage of linear and nonlinear programming, search techniques, and metaheuristics for advanced optimization. Emphasis on practical applications in polymer engineering and operations research, with a focus on constraint handling and solution strategies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-505

Course Title: Polymer Blends and Composites

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Particulate Polymer Composites; Short Fiber Reinforced Polymer Composites; Continuous Fiber Reinforced Thermoset Composites; Continuous Fiber Reinforced Thermoplastic Composites; Polymeric Nano Composites; Polymer blend miscibility; Compatibility and compatibilization; Molecularly Reinforced Polymer Blends; Rubber Toughened Plastics; Interpenetrating Polymer Networks

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-506

Course Title: Polymer Colloids

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Polymer colloids, latex, industrial production & applications; Stability & non-stability of polymer colloids: Electrostatic interaction & steric stabilizer through polymer brush & stabilizers; DLVO theory, fast and slow coagulation; Preparation of aqueous phase polymer colloids: Emulsion polymerization, theories of colloidal particle growth and characterization by DLS, SLS, and neutron scattering; Non-aqueous based polymer colloids: Particle formation & growth kinetics, non-radical polymerization, inverse emulsion polymerization; Practical application of Polymerization: Batch, CSTR, multi-CSTR in series reactors; Chemistry at interface: Functionalization & applications, drug carriers and polymer colloids enhanced reaction kinetics; Rheology of polymer colloids.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-507

Course Title: Product Standardizations and Regulatory
Standards in Polymers

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Understanding of Polymer Testing; Specimen Preparation Technique; Mechanical Properties; Thermal Properties; Chemical property; Optical Properties; Rheological Properties; Morphological properties of polymers; Electrical properties; Non-Destructive Testing and Product Testing.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-510

Course Title: Bio and Bio-medical Polymers

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Biocompatibility; Biodegradable Polymers; Hydrogels and Crosslinked Polymers; Natural Polymers; Synthetic Polymers; Stimuli-Responsive Polymers; Drug Delivery; Tissue Engineering; Blood-compatible Polymers; Blood-compatible Polymers

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-511

Course Title: Heat and Mass Transfer in Polymeric Materials

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Basic of mass transfer, Conduction, Forced and natural convection, Heat transfer by radiation, Boiling and Condensation, Heat exchanger, Evaporation, Interphase mass transfer, overall mass transfer coefficient, analogy between momentum, heat and mass transfer, concept of stage wise contact processes, HETP, HTU and NTU concepts, equipment used in gas-liquid operations, co-current and counter current absorption processes; Simultaneous heat & mass transfer, humidification & drying, Lewis relation, equilibrium in drying, classification and selection of industrial dryers; Crystallization, Application of heat and mass transfer in polymer processing, molding & extrusion.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-512

Course Title: Quality Management

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Quality Improvement in the Modern Business Environment; Modeling Process Quality; Inferences about Process Quality; Methods and Philosophy of Statistical Process Control (SPC); Process and Measurement System Capability Analysis; Cumulative Sum and Exponentially Weighted Moving Average Control Charts; Univariate Statistical Process Monitoring and Control Techniques; Engineering Process Control (EPC); Factorial and Fractional Experiments for Process Design and Improvement; Process Optimization with Designed Experiment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-513

Course Title: Functional Polymers and Semiconductors

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Basic concept of functional & semiconducting materials, electroactive and stimuli-responsive polymers, self-healing, stretchable, biodegradability, shape-memory and phase change polymers. Functionalized nanofiber and porous membranes, semiconductor fundamentals and processing, conjugated and ionic polymers.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-514

Course Title: High Performance and Conducting Polymers

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Structure, Property and Application of High Performance Thermoplastics, example, Polyimide, Polysulphone, PEEK, PPO, PPS, Structure, Property and Application of Thermally Stable Polymers: Polyether imide, polyester imide, Polybismelimites, Polyurethane and Polyacetals, Conducting Polymers: Structure, mechanism of Conduction, preparation of conducting polymers, Photoconducting and Photoresist Polymers and their applications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-515

Course Title: Polymer Film & Fibre Technology

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Structure, property, and morphology of polymer fiber, films and sheets; Processing of fiber and films- spinning and extrusion, die design, equipment and machinery, post-processing operations and yarn synthesis; Types of films, characterization- fiber density, birefringence, tensile properties and moisture sensitivity, Production and application.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-516

Course Title: Polymer Degradation & Recycling

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Chemical structure and its role in degradation, Advantages, Disadvantages and Case studies from industry, Thermo-oxidative degradation mechanisms and effect on product properties, Photo and Photo-Oxidative Degradation, Antioxidant and Stabilizers, Degradation in special environments – harsh, ultrasonic and radioactive, Degradation of polymer biomaterials and drug release, Biodegradable polymers and recycling with case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-517

Course Title: Paint and Coating Technology

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Fundamental concepts of paint technology, including the ingredients of paints and their functions, along with the mechanisms behind paint formulation and manufacturing. Detailed exploration of raw material and paint characterization, as well as paint application techniques, including surface preparation. Focus on the formulation of architectural and industrial paints; with an emphasis on high-performance coatings.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-518

Course Title: Polymer Processing

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Fundamentals of Polymer Processing, Polymer Extrusion, Injection Molding, Compression Molding, Blow Molding Technology, Resin Transfer Molding, Fiber Spinning, Polymer Foams, Miscellaneous Processing Technologies, Transfer Molding, Rotational Molding, Thermoforming, Hand & Spray Layup, Calendaring, Filament Winding, Pultrusion, Tooling & Mold Design.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-519

Course Title: Polymer Reaction Engineering

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Ideal Reactors (design equations of Batch, CSTR, PFR), Single and Multiple reaction systems, yield, selectivity; Non-isothermal reactions and stability analysis, Heterogeneous reactions, Deactivating catalysts and G/L reactions on solid catalysts, Reaction Engineering of Step Growth and Free Radical Polymerizations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-520

Course Title: Advanced Process Control

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Introduction to Laplace Transforms, Types of systems-first order and second order systems, interacting and non-interacting systems; Process Control and Strategies, Stability, Modes of control actions and controller tuning; Computer-based control systems; Advanced Control systems- Cascade control, Feed-forward control, Ratio Control, Internal Model Control, State-space methods.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-521

Course Title: Polymeric Membrane Technology

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Fundamentals of separation, diffusion across porous barriers; Membrane materials: polymeric materials, ion-exchange and bio-polar materials; Polymeric membrane preparation and influence of polymeric solution thermodynamics: Sintering, stretching, track-etching, template leaching, interfacial polymerization, phase inversion; Characteristics of membrane material and products; Membrane Processes: Pressure driven and osmosis membrane processes for water and gas separation, large scale application of RO; Transport in membrane, within flow channel of membrane and fouling: modeling crossflow membrane process and hollow fiber membrane module; Ion-exchange membrane preparation and application; water splitting, fuel cell.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-522

Course Title: Molecular Engineering

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Thermodynamics and its role in molecular engineering, laws of thermodynamics, Boltzmann distribution and occupation of states, Solvation and kinetics of molecules, surface tension from energy, diffusion equations, microscopic dynamics, ratchets, chemical kinetics and transition of states, Landscapes for polymer folding, Polymer conformation, interaction and hybridization, Thermodynamics of DNA hybridization and Polyelectrolytes, Polymers in solvent and in confinement, Phase-transition and co-operativity models, Functional building blocks for molecular design, Molecular Machines.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PEL-523 **Course Title:** Polymers for Energy Generation and Storage

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Fundamentals of energy technology, basic concepts of dielectric polymer, conducting polymers, and semiconducting polymer. Polymers for energy harvesting technologies (piezoelectric, triboelectric, thermoelectric, photovoltaic) and energy storage technologies (supercapacitors, batteries).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PET-501

Course Title: Polymers for Advanced Applications

L-T-P: 3-0-0

Credits: 3

Subject Area: STAR

Course Outlines: Importance of plastics in modern society; biodegradability: myths and reality; polymers in healthcare and safety; polymers as a safe, hygienic medium for packaging foods and food products; polymer: materials for national security; fuel-efficient modern automobiles- contribution of polymer; resource conservation land, water, forests, and energy, recycling of plastics and integrated waste management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Polymer and Process Engineering

Subject Code: PET-502

Course Title: Membrane Fabrication & Applications

L-T-P: 3-0-0

Credits: 3

Subject Area: STAR

Course Outlines: Fundamentals of membranes and applications, preparation of polymeric and inorganic membranes and fabrication of membrane modules, polymeric membranes for MF, UF, RO, FO processes, and gas separation; Influence of polymeric solution thermodynamics on membrane performance; Sintering, stretching, track-etching, template leaching, interfacial polymerization, phase inversion; Characteristics of membrane material and products; Membrane Processes: Pressure driven and osmosis membrane processes for water and gas separation, large scale application of RO; High tech applications of membrane.