PLPC2002 CHEMISTRY & PHYSICS OF POLYMERS (3-0-0)

Course Objective: The course aims to provide students with a comprehensive understanding of polymer science, covering topics such as polymerization mechanisms, characterization techniques, and structure-property relationships. By exploring various polymerization methods and their applications, students will develop critical analytical skills necessary for assessing polymer properties.

Syllabus

MODULE — I (10 Hrs.)

Basic concepts of macromolecules - Monomers- Functionality - Classification and nomenclature of polymers. Types of polymerization —Addition polymerization- Initiator systems — Catalyst systems Zieger Natta catalyst, Metallocene catalyst - Mechanism and kinetics of free radical- Cationic- Anionic Polymerisation — Control of molecular weight- Chain transfer- Inhibition – Coordination polymerisation-Mechanism - Kinetics- Ring opening polymerization - Diene polymerization — Advanced Polymerization Techniques - Atom Transfer Radical Polymerization (ATRP), Group Transfer Polymerization (GTP), Reversible Addition Fragmentation Termination (RAFT).

MODULE —II (09 Hrs.)

Copolymerization - Mechanism and Kinetics of free radical - Ionic copolymerization. Types of copolymers- Copolymer composition - Determination of Monomer reactivity ratios. Polymerization techniques- Bulk polymerization- Solution polymerization – Suspension polymerization - Emulsion polymerization - Interfacial condensation.

MODULE - III (08 Hrs.)

Condensation or step growth polymerization - Mechanism - Kinetics - Bi-functional systems – Poly functional systems- Molecular weight- Molecular weight averages- Molecular weight distribution-Unidispersity, polydispersity, degree of polymerization - Molecular weight determination – Basic concepts of end group analysis, colligative properties, osmometry, light scattering, and gel permeation chromatography - Viscosity of polymers solutions, size of the polymer molecules.

MODULE - IV (08 Hrs.)

Potential energy and conformational energy of molecules - Staggered and eclipsed states - conformations and configurations, isomeric states and isomerism in polymers - Tacticity, stereoisomerism, geometric isomerism - Unperturbed and Gaussian chains - Random coils and average end to end distance - Freely jointed and freely rotating chain models — Random flight analysis.

MODULE — V (10 Hrs.)

Amorphous State - Transition temperatures - Glass transition temperature - Free volume, kinetic, and thermodynamic views of glass transition - Factors influencing glass transition temperature. Crystalline State - Crystal systems, unit cells, primitive cell, Bravais lattices, polymorphism - Polymer single crystals, lamellae, spherulites, suprarmolecular structures, fringed micelle model - Degree of crystallinity, factors affecting crystallinity - X-ray diffraction. Chain orientation - Concept of chain orientation - orientation in amorphous and crystal line polymers - Uniaxial and biaxial orientation practical significance - Orientation processes – fibre spinning, blown film extrusion, solid state extrusion, profile extrusion - Properties of oriented polymers - Birefringence

Books:

1. Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA, 1994.
2. F.W. Billmeyer, —Textbook of Polymer Sciencel, Wiley international publishers, 2000 • George Odian , — Principles of polymerisation!, Seymor Robert
3. V.R. Gowariker, —Polymer Sciencel – New Age International (P) Ltd, Publishers
4. Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995
5. .M.G. Cowie, Polymers: Chemistry and Physics of Modem Materials!, Blackie, and London, 1991.
6. R.J. Young and P.Lovell, Introduction to Polymers!, 2nd Ed., Chapman & Hall, 1991.
7. Premamoy Ghosh, —Polymer Science and Technology of Plastics and Rubbers Tata McGraw- Hill, New Delhi, 1990.

Course outcomes: ***After the completion of this course, students will be able***

CO1	To understand the fundamental concepts of macromolecules, facilitating their comprehension of polymer nomenclature and classification
CO2	Through an understanding of copolymerization mechanisms and polymerization techniques, students will design copolymers with tailored properties for specific applications.
CO3	Students will demonstrate proficiency in characterizing polymer molecules and determining molecular weight distributions using advanced analytical techniques.
CO4	To understand polymer structure and its influence on properties
CO5	To analyses the properties of polymers in different states, along with understanding chain orientation processes, enabling them to engineer polymer products with desired properties