Master of Science, Chemistry
M. Sc. Chemistry, Semester – I

Course Code	PS01ECHE51	Title of the Course	Polymer Chemistry
Total Credits of the Course	**4**	Hours per Week	4

Course Objectives:	• The course gives a general introduction to polymers and address the need of the hour. • To study the fundamental concepts of polymer chemistry. • To study the structure of monomers, functionality, and classification of polymers basis of source, composition, conditions, molecular weight, geometry, and Nomenclature of polymers. • To study the various methods and techniques of polymerization reactions, their chemistry, mechanism, structures, properties and applications. • The course will help in understanding basic concept of polymer and its synthesis. • To study various polymerization methods and their kinetics.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction: Historical development in polymeric materials, Basic concepts: Oligomer, Monomer, Polymer, Polymerization and Functionality, Repeating Unit, Degree of Polymerization, Bonding in Polymers, Notation and Nomenclature of Polymers, Classification of Polymers, Glass Transition Temperature (T_g) and Factors Influencing the Glass Transition Temperature Average Molecular Weight Concepts and Measurement of Molecular Weights (Mn, M_w and M_z): Number Average and Weight Average Molecular Weights, Molar Mass & Molar Mass Distribution, Polydispersity, Method of Working out Weight Average Molecular Weight and Number Average Molecular Weight, Molecular Weight and Degree of Polymerization, Polydispersity and Molecular Weight Distribution in Polymers, Practical Significance of Polymer Molecular Weight, End Group Analysis, Freezing Point Depression (Cryoscopy), Boiling Point Elevation (Ebullioscopy), Membrane Osmometry, Vapour Phase Osmometry, Dilute Solution Viscosity, Light Scattering, Ultracentrifugation and GPC	25
2.	Chain-Growth Polymerization: **(i)** Chain Radical (Addition) Polymerization: Free radical addition polymerization mechanism of vinyl polymerization(Generation of free radicals, initiation, propagation, termination, chain transfer inhibition of retardation, configuration of monomer units in vinyl polymer chains), Methods of Initiating Free Radical Polymerization, Kinetics of free radical addition polymerization (experimental determination of rate constants, derivations for rate expressions and	25

	expressions for kinetic chain length, degree of polymerization and average life time of a kinetic chain),Control of molecular weight by transfer, The Mayo Equation and Evaluation of the Chain Transfer Constant, Factors (Temperature, Initiator Concentration, Monomer Concentration and Pressure) determining radical polymerization and the properties of the resulting polymer, Equilibrium of Radical Polymerization **(ii)** Ionic (Catalytic) Polymerization - common features of two types of ionic polymerization, Mechanism of cationic polymerization, expressions for overall rate of polymerization and the number average degree of polymerization. Mechanism of anionic, polymerization, expressions for overall rate of polymerization and the average degree of polymerization, Living polymers. (iii) Coordination (Insertion) Polymerization: Ziegler – Natta Catalysis	
3.	Step-growth Polymerization, Kinetics of catalyzed and non – catalyzed polyesterification, Ring – opening Polymerization (Mechanism of polymerization of cyclic ethers, cyclic amides and cyclosiloxanes), Atom transfer Polymerization, Ion Containing Polymers Polymerization in Homogeneous and Heterogeneous Systems: Homogeneous system, Heterogeneous System, Suspension Polymerization, Emulsion polymerization, Interfacial Condensation, Solid and Gas Phase Polymerization, Salient features of different polymerization techniques Miscellaneous Polymerization: Group Transfer Polymerization, Metathetical Polymerization, Electrochemical Polymerization.	25
4.	Copolymerization: Free Radical Copolymerization, Determination of Reactivity Ratio, Reactivity Ratios and Copolymerization Behaviour, Copolymer Composition at Higher Conversations, Structure and Reactivity of Monomers and Radicals, The Q-e scheme of Alfrey and Price Polymer Reactions: Hydrolysis, Acidolysis, Aminolysis, Hydrogenation, Addition reactions, Substitution reactions, Reaction of Hydroxyl Groups, Reaction of Ketonic Groups, Reactions of Carboxylic Groups, Reaction of Aldehyde Groups, Reaction of Amino Group, Reaction of Amide Group, Cyclisation Reaction, Cross-linking reactions and Vulcanisation Polymer solubility and solutions: Introduction, General rules for polymer solubility, Thermodynamic basis of Polymer Solubility, Prediction of Solubility, Examples based on the calculation of the solubility parameter for solvent & polymer. Additives for Polymers	25
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Teaching-Learning Methodology	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material form the Department/University/Digital Library Service.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Basics about polymers, kinetics, mechanism of basic techniques of synthesizing polymers and methodology used of control molecular weight of polymers
2.	Describe the general structure of polymers
3.	Identify and explain differences between addition and stepwise polymerization.
4.	Role of chain transfer agents, retarders, inhibitors for controlling molecular weight and shelf life of polymer.
5	General applicability of various polymers and knowledge of various materials used for improving properties of polymers and carry out a polymer synthesis based on a given protocol
6	Utility of copolymerization reaction mechanism and preparation of different techniques of polymerization of polymers.

Suggested References:	
Sr. No.	References
1.	Polymer Science by V. R.Gowariker, N. V. Viswanathan and JayadevSreedhar, New Age International Publishers.
2.	Polymer Chemistry – An Introduction by Malcom P. Stevens, Addison Wesley Publishing Co. Inc. Massachusetts.

3.	Textbook of Polymer Science by F. W. Billmeyer, Wiley – Interscience, New York
4.	Introduction to Polymer Chemistry by R. B. Seymour,Mc – Graw – Hill, New York
5.	Principles of Polymer Science (Second Edition) by P. Bahadur and N. V. Sastry, Narosa Publishing House, New Delhi
6.	Introduction to Polymer Chemistry by R. J. Young and P. A. Lovell
7.	Principles of Polymers Systems, F. Rodriguez, Hemisphere, Publishing Corporation, Washington, DC.
8.	Polymer Chemistry by C. Carraher, Marcel Dekker Inc., New York-Basel
9	Odian, G., 2004, Principles of Polymerization, Wiley – Interscience.
10	Polymers : Chemistry &Physics of Modern Materials-J.M.G. Cowie-Nelson Thornes Ltd. 1990

On-line resources to be used if available as reference material
On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.

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