GUJARAT TECHNOLOGICAL UNIVERSITY

PLASTIC ENGINEERING (23)

INTRODUCTION TO PLASTIC MATERIAL SCIENCE

SUBJECT CODE: 2132301

B.E. SEMESTER III

Type of course: Theoretical + Practical (Regular)

Prerequisite: Basic knowledge of organic chemistry

Rationale: Correlate appropriate polymerization methods and techniques along with transition temperature, molecular weight and morphological properties

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Introduction:** Basic concepts-What are polymers-How are they made-Natural & Synthetic polymers-forms of polymers-Copolymerization.	04	5
2.	**Chemistry of polymerization** **(a) Addition polymerization** Chain Polymerisation- Free radical polymerization- Initiators, polymerization mechanism, Chain transfer, Inhibitors and retarders, Ionic polymerization-coordination polymerization-Ziegler Natta catalyst. **(b) Condentation polymerization** Step polymerization- Polycondentation- Polyaddition polymerization – Ring opening polymerisation	10	20
3.	**Methods of polymerization** Bulk - solution - Suspension - Emulsion - Gas phase polymerization techniques in detail with examples – Suspension polymerization of PVC, Bulk Method for manufacture of PMMA sheet, etc. factors affecting the poly methods with respects to various parameters.	5	10
4.	**Molecular weight and size:** Introduction- Mol.wt.averages- Mol.wt.distribution of Mol.Wt.-Mol.Wt. & physical properties-Secondary valency forces. Mol. Wt. & degree of polymerization-Polydispersity & Mol.wt. Distribution in polymers-Practical significance of polymer mol.wt.-size of polymer molecules	04	15
5.	**Stereochemistry of Polymers:** Introduction-Configuration and Confirmation features- Tacticity - General remarks on polymer micro structure-micro structures	4	10

	based on the chemical structure- micro structures based on the geometrical structure		
6.	**Glass transition temp. (Tg):** What is Glass Transition Temp.- Glassy solids & Glass transition –Transition & Associated properties-Factors influencing the Tg.-Mol.wt.& Tg.-plasticizers & Tg.-Tg. Of copolymers-melting point & Tg.-importance of Tg. & HDT	6	15
7.	**Crystallinity in polymers: Introduction**: Crystalline solids & their behavior towards x-rays-polymers & x-ray diffraction-degree of crystallinity & its measurement-polymer crystallization -crystallisability -crystallites determination of crystallites size structural regularity & crystallisability-factors affecting crystallisability sperulites -Folding of chain during crystal formation- Effect of crystallinity on properties of polymers like Nylons, HDPE, PPO,etc	6	15
8.	**Polymer reactions and polymer reactants** Introduction - Hydrolysis - Acidolysis - Aminolysis – Hydrogenation -Reactions of various specific groups. Introduction - cyclization reaction -halogenation - cross linking reactions - polymer reactants	3	10

Reference Books:

1. V.R.Gowarikar and N.V.Viswanathan, "Polymer Science", Willey eastern limited.
2. Polymer Science and Technology" by Premamoy Ghosh
3. George Odian, "Principles of Polymerization", Wiley Interscience.
4. G.S. Misra, "Introductory Polymer Chemistry", Willey eastern limited.
5. Fred W. Billmeyer , "Text Book of Polymer Science" , John Wiley & sons.
6. Polymers chemistry by Stevens.

Course Outcome:

After learning the course the students should be able to: Perform the polymerization of monomers, understand about molecular weight, crystallinity and amorphous structures, glass transition temperature.

List of Practical:

1. To prepare a polymer by free radical polymerization.
2. To prepare a polymer by step polymerization.
3. Bulk Method for manufacture of PMMA sheet.
4. To prepare a polymer by emulsion polymerization.
5. Hydrolysis of a given polymer sample.
6. Acidolysis of given polymer sample

Open Ended Problems/Design Oriented Problems:

- Identify the monomers for polymer sample.
- Determine the Weight average Molecular Weight and Number average Molecular Weight of polymer sample.
- Determine the concentration of polymer after hydrolysis.
- Determine the concentration of polymer after acidolysis

Major Equipments: Three neck round bottom flask, condenser, hot plate, heating mantle.

List of Open Source Software/learning website: : www.plasticsnet.com / www.nptel.ac.in/ www.wikipedia.com /www.mit.edu

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.