



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Plastics Engineering

Subject Code: BE03053011

Subject Name: Polymer Chemistry: Reaction & Properties

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	PCC

Prerequisite:	Basic knowledge of organic chemistry
Rationale:	Understand and correlate appropriate polymerization methods and techniques along with stereochemistry, molecular weight, transition temperature, crystallinity and viscosity.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes
01	Perform the polymerization of monomers
02	Understand about molecular weight, stereochemistry, crystallinity and amorphous structures, glass transition temperature, and viscosity.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	15	30	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction: Basic concepts-What are polymers-How are they made-Natural & Synthetic polymers-forms of polymers-Copolymerization.	03	05
2.	Chemistry of polymerization: (a) Addition polymerization: Chain Polymerization- Free radical polymerization- Initiators, polymerization mechanism, Chain transfer, Inhibitors and retarders, Ionic polymerization-coordination	07	20



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	polymerization- Ziegler Natta catalyst. (b) Condensation polymerization: Step polymerization- Polycondensation- Polyaddition polymerization – Ring opening polymerization.		
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 polymerization methods with respect to various parameters.	05	15
4.	Molecular weight and size: Introduction- Mol. wt. averages- Mol. wt. distribution - Mol. wt. & physical properties-Secondary valence forces. Mol. wt. & degree of polymerization- Polydispersity - Distribution in polymers- Practical significance of polymer mol. wt.- size of polymer molecules.	04	10
5.	Stereochemistry of Polymers: Introduction- Configuration and Conformation - Tacticity - General remarks on polymer micro structure- micro structures based on the chemical structure- micro structures based on the geometrical structure.	04	10
6.	Glass transition temp. (T_g): What is Glass Transition Temp.- Glassy solids & Glass transition – Transition & Associated properties- Factors influencing the T_g - Mol. wt. & T_g - plasticizers & T_g - T_g of copolymers- melting point & T_g - importance of T_g & HDT.	05	10
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 spherulites - Folding of chain during crystal formation- Effect of crystallinity on properties of polymers like Nylons, HDPE, PPO, etc.	06	15
8.	Polymer reactions and reactants: Introduction - Hydrolysis - Acidolysis - Aminolysis – Hydrogenation - Reactions of various specific groups. Introduction - cyclization reaction - halogenation - cross linking reactions - polymer reactants.	05	05
9.	Viscosity of polymers: Dynamic viscosity, Kinetic Viscosity, Mark-Houwink equation, Fluid	06	10

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flow- types of fluid flow- time dependent fluids, Newtonian, Non-Newtonian fluids - Viscosity of polymer melts, shear thinning and shear thickening- zero shear rate viscosity- laminar flow of Newtonian fluids- power law- general treatment of isothermal viscous flow in tubes.		
Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
Where R: 2.5 Remember; U: 5 Understand; A: 10 Apply; N: 5 Analyze; E: 10 Evaluate; C: 10 Create (as per Revised Bloom's Taxonomy)					

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

References/Suggested Learning Resources:

(a) Books:

1. "Polymer Science" by V.R. Gowarikar and N.V. Viswanathan, Wiley Eastern Limited.
2. "Polymer Science and Technology" by Premamoy Ghosh, Tata McGraw Hill.
3. "Principles of Polymerization" by George Odian, Wiley Interscience.
4. "Introductory Polymer Chemistry" by G.S. Misra, Wiley Eastern Limited.
5. "Textbook of Polymer Science" by Fred W. Billmeyer, John Wiley & Sons.
6. "Polymers Chemistry" by Malcolm P. Stevens, Oxford University Press.
7. "Polymer Science and Technology" by Joel R. Fried, Prentice Hall.

(b) Open source software and website: www.plasticsnet.com / www.nptel.ac.in

Suggested Course Practical List: If any

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 a given polymer sample.



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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 Equipment: Three-necked round bottom flask, condenser, hot plate, heating mantle.

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

• **List of suggested activities for Problem Based Learning:**

S.N.	Self Learning Activity
1	MOOCS courses
2	College Library
3	Digital Library
4	National Digital Library of India
5	Society of Plastic Engineering (SPE) Digital Library
6	One Nation One Subscription (ONOS) for Journal Papers

- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.
