GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Course / Subject Code: ME01072051

Course / Subject Name : Introduction to Polymer Science

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Basic knowledge of polymer chemistry at undergraduate level.
Rationale:	The main theme of this course is to focus on understanding of polymer science, its technology, Polymer synthesis and its characterization. Knowledge of properties of polymers will enable their proper selection for applications in domestic as well as industrial appliances.

Teaching and Examination Scheme:

			Total Credits L+T+ (PR/2)	**Assessment Pattern and Marks**				**Total Marks**
				Theory		**Tutorial / Practical**		
L	**T**	**PR**	**C**	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** Basic concepts of monomer, Types of monomers, Functionality of monomers, Basic concepts of polymer, global trends for consumption of polymers, Effect of functionality on polymer structure, Chemical and geometric structure of polymer, Configuration and conformation, Linear, Branched and cross-linked structure, Random, Alternating, block and graft polymers, Stereo regular polymer, Classification of polymers based on: sources, structures, configuration, application, tacticity, crystalline etc..	06	13

2.	**Basic concepts of polymer:** Polymer application, mechanism and kinetics of polymerization, mode of formation, poly dispersity and molecular weight distribution, Concept of Mn(Number average molecular weight), Mw((Weight average molecular weight), Mv(Viscosity average molecular weight) and Mz(Z average molecular weight) and measurement techniques, effect of molecular weight on polymer end use properties also discuss the relevant case studies, Theory of polymer solutions: solubility parameter, Mark-Houwink-equations	10	22
3.	**Addition/Chanin growth Polymerization:** Mechanism and kinetics of free radical, anionic, cationic and co-ordination polymerization, initiator efficiency, types of initiation reactions, auto acceleration chain transfer agents, inhibition and retardation reactions, case studies for addition polymerization reactions	07	16
4.	**Condensation/Step growth polymerization:** Carothers's equation, kinetics of step growth polymerization, cross-linking and gelation, Comparison between addition and condensation polymerization, Co polymerization: Typesof co polymers, monomer reactivity ratio, block and graft copolymers, case studies for condensation polymerization reactions	07	16
5.	**Polymer Degradation:** Polymer degradation (chain and random), Methods of degradation of polymers such asmechanical, thermal, photo, oxidative and bio degradation	05	11
6	**Polymerization Reaction Engineering:** Techniques of Polymerization, Bulk polymerization, Solution polymerization, Suspension polymerization, Emulsion polymerization, Comparison of bulk, solution, emulsion and suspension polymerization techniques, Reactors for polymerization, Reactors for Industrial polymerization Processes like manufacturing of PS, PBR, SBR, PE, HDPE, LDEP etc.	08	18
7	**Rheology of Polymeric System:** Unit operations in polymer industries, Introduction to Polymer processing, injection molding, calendaring, extrusion etc.	02	4
	Total	**45**	**100**

Course Outcomes:

After Completion of the Course, Student will able to:

No.	Course Outcomes	
01	Understand the basic concepts of polymers and characterize polymers based on their properties	**U**
02	Demonstrate an ability to distinguish different polymerization reactions and their Mechanisms /kinetics.	**U**
03	Relate polymer degradation in daily life	**U**
04	Compare various types of polymerization techniques for synthesis of polymer	**A**
05	Inference the knowledge to bridge the theoretical and practical concepts used in industry	**A**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
7	21	14	14	7	7

here R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as perRevised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Polymer science and technology, Joel R. Fried, Prentice Hall India Pvt. Ltd.
2. Polymer Science, Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, The new age international Pvt. Ltd.
3. Textbook of Polymer Science, Fred W. Billmeyer, John Willy and Sons.
4. Principles of polymer system, Ferdinand & Rodriguez
5. Principles of polymerization Geroge Odian, John Willy and Sons.

(b) Open-source software and website:

1. NPTEL lecture series.
2. MIT Open course lecture on Polymer technology.

Suggested Course Practical List: If any

List of Experiments: (Minimum 06 experiments need to be performed)

1. Bulk polymerization of styrene.
2. Solution polymerization of acrylonitrile.
3. Emulsion polymerization of methylacrylate.
4. Synthesis of Phenol Formaldehyde (PF) by condensation polymerization.
5. Synthesis of Urea Formaldehyde (UF) by condensation polymerization.
6. Synthesis of Polyurethane
7. Determine the properties of UF resins
8. Determine the properties of PF resins
9. To study injection molding machine: Different materials and molds; and optimization of cycle Time.
10. Determination of melt flow index for different materials.
11. To study injection molding.
12. To study extrusion molding.

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