



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3163614

Semester – VI

Subject Name: SYNTHESIS OF THERMOSETS

Type of course: Chemical Technology

Prerequisite: Student should know the basics of polymeric materials.

Rationale: The main objective of this subject is to provide the knowledge about the different types of thermosets materials and its synthesis processes.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Epoxy resins: Raw materials like epichlorohydrin and di hydroxy phenol. Classification of epoxy resins and Synthesis of epoxy resins. Ratios of reaction components and their effect on the properties of reaction product and molecular weight in particular. Curing of the resin: curing agents like amines, acids, anhydrides, etc.	10
2	Polyester resins: Unsaturated polyester resins, composites & fibre reinforced polyesters, Alkyd resins- Modified alkyls, raw materials, oils & film forming materials	7
3	Amino resins: Basic raw materials, synthesis and applications of UF & MF resins.	5
4	Phenolic: Phenolic resins- Alkali catalyzed & acid catalyzed reactions, CNSL based resins.	5
5	Polyurethanes: Basic components: diisocyanates and diols, different diisocyanates and diols used and Reactions of isocyanates with various other functional groups Synthesis of polymers Polyurethane foams, polyester and polyether foams. Processes like one-shot process, Polyether pre-polymers, Quasi-pre-polymer polyether foams, etc.	7
6	Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc.	8
7	Vulcanization: Technology of Cross linking processes Technology of Vulcanization & Devulcanization of rubbers.	5



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Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	05	05	05	05

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (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.

Reference Books:

1. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
2. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
3. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
4. Ellis, B. (ed.) (1993). Chemistry and Technology of Epoxy Resins. Springer Netherlands. ISBN 978-94-010-5302-0
5. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
6. Text book of Polymer Science, Billmeyers, John Wiley & Sons 1984.
7. Encyclopedia of Polymer Science & Technology, John Wiley & Sons, Inc 1965
8. Encyclopedia of Polymer Science & Engineering, John Wiley & Sons, Inc 1988.
9. Introduction to Polymer Science & Technology, H.S.Kaufman & J.J.Falcetta, Wiley – Interscience Publication, 1977
10. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D.Van Nostrand Company Inc, 1959.
11. Brydson, J. A. Plastics materials; Butterworth-Heinemann; 7 edition, Iliffe; London, 1966.
12. W. Mayo Smith, Manufacture of Plastics - Vol. I & II; Van Nostrand Reinhold; New York, 1964
13. Irvin. I. Rubin, Hand Book of Plastics Materials & Technology; John Wiley & Sons Inc.; New York, 1990.
14. Practicals in Polymer Science - Synthesis and Qualitative & Quantitative Analysis of Macromolecules, Dr.Siddaramaiah, CBS publishers & distributors pvt ltd. New Delhi 2012.
15. Introduction to Rubber Technology, Andrew Ciesielski, RAPRA Publications, 2000
16. Rubber Technology, Maurice Morton, Springer, 1st Ed, 1987



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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the knowledge about the basic concepts such as chemistry and various raw materials for the synthesis of epoxy resins.	20
CO-2	To identify the knowledge of unsaturated polyester resins and its properties and applications in coating industries.	25
CO-3	To apply this knowledge for the Chemistry, synthesis process, properties and applications of amino resins with real world situation.	25
CO-4	To analyze the chemistry of Alkali catalyzed & acid catalyzed reactions of phenolic resins.	10
CO-5	To formulate speciality polymeric materials such as polyurethanes and thermosetting acrylics.	10
CO-6	To correlate between theoretical and practical concept used in industry by studying the vulcanization and Devulcanization processes of rubbers.	10

List of Experiments:

1. To synthesis polymer using Bulk, solution, suspension & emulsion polymerization method.
2. To study auto acceleration by solution polymerization method.
3. Synthesis of copolymers by emulsion Bulk, solution & suspension and emulsion, Polymerization.
4. Synthesis of urea - formaldehyde by condensation polymerization.
5. Estimation of the extent of polymer in different solvent.
6. To study the properties and applications of PF resin.
7. Synthesis of polyurethane.

List of Open Source Software/learning website:

- 1) www.iri.net.in
- 2) www.ipiindia.org
- 3) www.plasticsnet.com
- 4) Delnet