GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3173626

Semester – VII
Subject Name: Polymer material, properties and structure

Type of course: Chemical Technology

Prerequisite: Student should know the basics of polymer and rubber materials.

Rationale: The main objective of this subject is to provide the knowledge about the detailed study on structures and properties relations of polymer and rubber materials.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	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	General Structural Features of Polymers- Chemical & Physical structure, Thermal behaviour, Glass Transition Temperature, Chain Flexibility, Crystallinity, Spherulites, Polymer Degradation & similar effects. The influence of processing parameters on the structure & properties of polymers & rubbers. Molecular mass heterogeneity and structure properties	**8**
2	Molecular Weight Determination Techniques: Study of the respective principles, theories & application by the following techniques : Gradient elution technique, Gel permeation chromatography, Vapour pressure Osmometry, Cryoscopy & ebullioscopy	**8**
3	Thermal Properties of Polymers- Glass transition temperature, melting temperature, heat distortion temperature, etc.	**6**
4	Basic concepts of Rheology- Viscosity of Polymers and rubbers, Power law, Melt solutions. Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry-Huggins theory.	**8**
5	Biopolymers: Classification and Introduction to biopolymers such as starch, sugar and cellulose, their properties and applications.	**8**
6	Microscopy and surface properties: Microscopy: Basic principle of electron microscopy; specimen preparation, structure determination of semi-crystalline polymers by scanning electron microscope (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM), Surface properties: Surface energy, contact angle measurements of polymers. Testing of flexible films for food applications, Permeability, Adhesion test, Peel test, shear test. Identification of polymers using chemical methods.	**7**

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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)

Reference Books:

1. Plastics Materials J. A. Brydson, Butterworth Scintific, 1990.
2. Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, 1974.
3. Structures of Cellulose, Atlla, American Chemical society, 2003.
4. Styrene Based Plastics and their Modifications, Svec, Ellis Harwood, 1991.
5. Properties of Polymer; Correlations with Chemical Structurees and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, 1990.
6. Biopolymers, Wiley, VCH Verlag, 2003
7. Relating Materials, Properties to Structure; Handbook and Software for Polymer calcilations and Materials Properties, D. J. david and Ashok Mishra, Technical Publishing Componey, Inc, 1999.
8. Polymer Association Structures M. A. EL-Nokally, American Chemical Society, 1989.
9. Polymer Solutions; Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, 2002.
10. Polymer Chemistry; An Introduction, M. P. Stevens, Oxford University Press, 1990.
    A. Brent strong ,'Plastics: Materials and processing', Prentice-Hall Englewood cliffs, 2006
11. Jozef.Bicerano, Prediction Of Polymer Properties, Second Edition, Marcel Dekker Inc. New York, 1995.
12. J.M.Margolis (Ed.), Engineering Thermoplastics Properties & Applications, Marcel Dekker, New York 1985.
13. R.J.Samuels, Structured Polymer Properties, John Wiley & Sons, New York, 1974.
14. F. Bueche, Physical properties of polymers, Wiley, New York, 1962.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the various structural features of polymeric materials.	20
CO-2	To identify the molecular weight of polymers by various techniques.	25
CO-3	To apply the knowledge of thermal properties to know about the actual structural features of polymers.	25
CO-4	To analyze the rheological properties of polymers.	10
CO-5	To be able to formulate biopolymers based on their structures and properties.	10

CO-6	To correlate between theoretical and practical concept by testing and analysis of polymeric materials.	10

List of Experiments:

1. Identification of polymers using chemical methods
2. Determination of molecular weight by end group analysis method.
3. Determination of molecular weight of polymers by viscosity method.
4. To study the morphology of polymeric material by SEM and TEM.
5. To find molecular weight & PDI of given polymeric sample by Gel permeation chromatography (GPC).
6. Peel test of films
7. Shear test of films

List of Open Source Software/learning website:

1. www.iri.net.in
2. www.ipiindia.org
3. Delnet
4. Literature available under R&D in Polymer & Rubber industry.
5. Polymer & Rubber journals
6. Polymer & Rubber dictionaries