



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3173622**

**Semester – VII**

**Subject Name: Sophisticated testing of polymers and rubbers**

**Type of course:** Chemical Technology

**Prerequisite:** Student should know the basics of polymer and rubber processing techniques.

**Rationale:** The main objective of this subject is to provide the knowledge about the different testing methods for polymer and rubber materials.

## 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	Basic Concepts and Advancements in Testing: Specifications and standards, Purpose of specifications.	8
2	Structural Evaluation of Polymers- Principles, theories & applications to polymers system with suitable illustration of the following techniques: Fourier transform infrared spectrometry, Ultraviolet Visible spectrometry, Nuclear magnetic resonance spectrometry, Mass spectrometry, X-ray diffraction spectrometry, Gas chromatography	8
3	Determination of Viscosity- Polymer solutions & polymer melts: Their significance, application to polymers using different viscometers. Determination of viscoelastic properties of polymers & rubbers. Testing of Rubber Compounds by Mooney viscometer and Determination of vulcanization properties by ODR and MDR.	8
4	Material Characterization Tests: Melt flow rate, Rheometer, Dilute solution Viscosity of Polymers. Tests for Elevated Temperature Performance: Heat deflection temperature, Vicat softening temperature. Thermal Analysis Techniques: DSC, TGA, TMA and DMT & their applications to polymers with suitable examples	7
5	Electrical Properties- Surface volume resistivity, Breakdown voltage. Arc resistance, Ten Delta, etc. The theory behind these phenomena, application to polymers & evaluation., Mechanical properties : Their principles & applications to polymers, Tensile strength, flexural strength, impact resistance,	8



# GUJARAT TECHNOLOGICAL UNIVERSITY

## Bachelor of Engineering

Subject Code: 3173622

	percentage elongation, Griffin theory, tear test, fatigue & wear, hardness, abrasion, compressive strength time dependant properties like creep, stress, relaxation, etc	
6	Environmental Resistance- Stress cracking, effect of weathering, biological degradation, fire radiation Staining. Optical properties: Refractive index, gloss, colour matching, haze. Fire test: Ignition of flame & spread, limiting oxygen index, rate of heat release, smoke toxicity test	6

### 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. Handbook of Plastics Analysis, H. Lobo & J.V. Bonilla, Marcel Dekker, 2003.
2. Handbook of polymer Testing Roger Brown, Marcel Dekker Inc, 1999.
3. Instrumental Methods. Dyer, Mc Graw Hill, 1997
4. Polymer Chemistry, Seymour and Carraher, Marcel Dekker, 2003
5. Handbook of Rubber Technology, S Blow, Galgotia Publications Pvt. Ltd, 1998
6. Developments in Polymer Characterization 1-5 by J. V. Dawkins
7. Handbook o Plastics Testing Technology, Vishu Shah, 2<sup>nd</sup> Edition, A Wiley-Interscience Publication.
8. D.A.Seanor, ed., Electrical properties of polymers, Academic press, New York, 1982.
9. I.M.Ward & D.W.Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley & Sons, Chichester, England, 1993.
10. C.C.Ku & R.Liepins, Electrical Properties of Polymers, Hanser Publications, Munich, 1987.
11. J.Mort & G.Pfister, eds., Electronic properties of polymers, Wiley Interscience, New York, 1982.

### Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To recognize the knowledge of basic concepts and advancements in testing of polymer and rubber materials.	20



# GUJARAT TECHNOLOGICAL UNIVERSITY

## Bachelor of Engineering

Subject Code: 3173622

CO-2	To identify and evaluate the structural features of polymeric material by various analytical techniques.	25
CO-3	To apply this knowledge to polymeric solutions by performing various viscosity measurements techniques.	25
CO-4	To analyze the polymeric materials by performing various characterization techniques.	10
CO-5	To be able to determine various electrical and mechanical properties of polymer and rubber materials.	10
CO-6	To correlate between theoretical and practical concept by the evaluation of various environmental resistance properties.	10

### List of Experiments:

1. Thermal properties of polymers and Rubbers: Differential scanning calorimetry (DSC) and Thermogravimetric analysis (TGA)
2. Determination of Glass Transition Temperature and % Crystallinity: DSC
3. Melt Flow Index
4. Structural characterization of polymers and Rubbers: Fourier transform infrared spectroscopy (FTIR) and Wide angle X-ray D (WAXD)
5. Determination of surface and volume resistivity of polymeric materials
6. Determination of dielectric strength of polymeric materials
7. Surface morphology of polymeric materials: Scanning electron microscopy (SEM)
8. Determination of limiting oxygen index
9. To Study the Abrasion resistance of rubber materials
10. Oscillating disk rheometer
11. Mooney Viscometer
12. Mechanical properties of polymeric materials: Universal testing machine (UTM)
13. To find Vicat softening point of given polymer sample.

### List of Open Source Software/learning website:

1. [www.iri.net.in](http://www.iri.net.in)
2. [www.ipiindia.org](http://www.ipiindia.org)
3. Delnet
4. Literature available under R&D in Polymer & Rubber industry.
5. Polymer & Rubber journals
6. Polymer & Rubber dictionaries