

# GUJARAT TECHNOLOGICAL UNIVERSITY

## RUBBER TECHNOLOGY (26)

Characterisation of Rubber

**SUBJECT CODE: 2162604**

**B.E. 6<sup>th</sup> SEMESTER**

**Type of course:** B. E. Rubber Technology

**Prerequisite:** NA

**Rationale:** NA

### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
3	0	3	6	70	20	10	20	10	20	150

### Content:

Sr. No	Course Content	Total Hrs	% Weightage
1.	Chemical Analysis : Comminution of the polymer sample, Separation of additives, Qualitative and quantitative investigation of the additives, Identification and quantitative analysis of isolated polymer samples.	8	15
2.	Introduction to Standard Organizations: like BIS, ASTM, ISO, BS, DIN etc. Their importance in the quality control of Rubber & Rubber Products, Preparation of test pieces conditioning & test atmosphere.	8	15
3.	Limitations of Test Results:- Statistics, Variability, Accuracy & Precision, Relevance & Significance, Sampling & Quality control, Treatment & Results, Design of Experiments.	8	15
4.	Analytical Analysis : (1) Chromatography : Gas Chromatography (GC), Thin Layer Chromatography (TLC), Gel Permeation Chromatography (GPC), High Performance Liquid Chromatography (HPLC). (2) Spectroscopy: Infrared Spectroscopy(IR), Fourier Transform Infrared Spectroscopy(FTIR), Nuclear Magnetic Resonance Spectroscopy(NMR), UV, Theory, Principle & Application of Rubber, Blends, Composites & Additives, Study of Thermal Transitions & Evolved Gas Analysis(EGA). (3) Microscopy :Applications & Principle of Optical Microscope, Scanning Electron Microscope, Transmission Electron Microscope, Phase Transition, Compatibility Evaluation, X-ray Diffraction Techniques (WAXS, SAXS), ESCA, ESR, Mass Spectroscopy.	12	20
5	Thermal Analysis : Principles & Applications (Tg, Crystallinity, Life Prediction, Kinetics of Degradation & Cp) of Thermo gravimetric Analysis(TGA), Thermo mechanical Analysis(TMA), Differential Thermal Analysis(DTA), Differential Scanning Calorimeters(DSC), DMA, DETA, Dilatometry of Rubbers, Rubber composites & blends, Thermo sets & Fibers.	12	20

	Thermal Analysis in Polymer Flammability : Introduction, Polymer Flammability, Thermal Analysis & Flammability Evaluation, Conclusions. Thermal Analysis of Additives in Polymers : Introduction, Protective agents, Plasticizers, Other Additives etc.		
6	Experimental Methods: Polymer synthesis, isolation & purification of polymers, polymer fractionation and determination of glass transition temp. etc	6	15

**Suggested specification table with marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	15	15	15	0

**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. Thermal Characterization of Polymeric Materials by Edvin A. Turi
2. Science & Technology of Rubber, by James E. Mark, Burak Erman, Frederick R. Eirich
3. Principles of Polymer Systems, by Ferdinand Rodriguez
4. Polymer Characterization-1989, - by Schroden
5. Understanding Polymer Morphology-1995, - by Woodhard
6. Thermal Degradation of Polymer Materials-2005, - by PIELICHOWSKI
7. Polymer Characterization Laboratory Techniques and Analysis by Nicholas P. Cheremisinoff

**Course outcome:**

After learning the content of the subject the students will be able to:

1. Know about the importance of characterization of rubbers.
2. Learn about Qualitative and quantitative investigation of the additives.
3. Able to understand the identification and quantitative analysis of isolated polymer samples.
4. Understand the limitation of results.
5. Know about Standard Organizations & understand its importance.
6. Learn the importance of thermal analysis of additives in polymers.
7. Learn about thermal analysis in polymer flammability.
8. Learn about analytical analysis by Chromatography, Spectroscopy & Microscopy.

**List of Experiments:**

Tutorials/Presentation/Practicals based on above topics

**Design based Problems (DP)/Open Ended Problem:**

- Characterization of natural rubber biosynthesis in *Ficus benghalensis*.
- Molecular analysis of cis-prenyl chain elongating enzymes.
- Preparation and characterization of rubber-toughened poly(trimethylene terephthalate)/organoclay nanocomposite.

**Major Equipments:**

Differential Scanning Calorimeters, UV Spectrometer etc.

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

- <http://www.biomedcentral.com/>
- <http://www.sciencedirect.com/>
- <http://onlinelibrary.wiley.com>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.