GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Branch: Rubber Technology
Subject Code ME02088041
Subject Name: Thermal & Thermal Analysis of Rubber & Rubbery Materials

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Basic knowledge of rubber technology , its characteristics and analytical techniques
Rationale:	The thermal analysis of rubbers and rubbery materials plays a pivotal role in understanding their behavior under varying thermal conditions, aiding in the development of materials with enhanced performance, durability, and efficiency. This subject provides a comprehensive understanding of instrumental techniques, characterization methods, and their applications in analyzing rubber-based systems. Thermal analysis techniques serve as a cornerstone for the scientific and industrial development of rubbers. By linking material properties to their thermal behavior, this subject facilitates the design and optimization of rubber-based products for diverse applications, from automotive to electronics.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Explain the instrumental techniques used for the thermal analysis of rubbers and rubbery materials.
C02	Analyze and interpret the methods used for the characterization of nanostructure materials.
C03	Utilize DSC (Differential Scanning Calorimetry) and TGA (Thermogravimetric Analysis) for the characterization of rubbers.
C04	Develop and establish structure-property relationships in particulate filler/rubbery matrix systems.
C05	Explain the thermal analysis techniques and their relevance to rubber products.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			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)	
03	00	02	04	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Instrumental Techniques used for Thermal Analysis of Rubbers and Rubbery Materials:** Introduction, Differential Thermal Analysis (DTA) , Differential Scanning Calorimetry (DSC), Derivative Thermogravimetry (DTG), Evolved Gas Analysis (EGA) or Evolved Gas Detection (EGD), Thermo mechanical Analysis (TMA) and Thermodilatometry (TD) or Thermodilatometric Analysis (TDA), Parallel Plate Rheometry (PPR), Stress Relaxation Spectrometry, Dynamic Mechanical Analysis (DMA), Torsional Braid Analysis (TBA), Thermally Stimulated Current (TSC), Relaxation Map Analysis (RMA), Differential Photo Calorimetery (DPC), Dielectric Analysis (DEA) or Dielectric Thermal Analysis (DETA).	9	20
2.	**Applications of DSC and TGA for the Characterization of Rubbers and Rubbery Materials:** Introduction, Differential Scanning Calorimetry of Rubbery Materials, Thermo gravimetric Analysis of Rubbery Materials, Thermal Degradation and Stability of Rubbers by TGA, Miscellaneous Applications of TGA	9	20
3.	**Micro-thermal Analysis of Rubbery Materials:** Introduction, Basic Principles of μTA, Modes of Micro-thermal Analysis, Microthermal Analysis of Rubbery Material, Morphological Investigation in Polymer Blends, Thin Films/Coating on the Substrate, Multilayer Material Characterization, Thermal Characterization of Micro-spheres, Powder Particle Characterization, Characterization of Microspores, Characterization of Nanostructure Material.	9	20
4.	**Thermal Analysis in Understanding Rubbery Matrix and Rubber-Filler Interactions:** Introduction, Thermal Analysis and Investigation of Heterogeneous Materials, Structure-Properties Relationships in Particulate Filler/Rubbery Matrix Systems, Description of the Shape and Space Distribution of Filler Particles, Filler-to-Matrix and Filler-to-Filler Interactions as Investigated by Thermal Analysis, Thermogravimetry, DTA and DSC.	9	20
5.	**Thermal Analysis of Rubber Products:** Introduction, Thermal Analysis of Rubber Based Vibration Control Devices, Thermal Analysis of Rubber Seals, Thermal Analysis of Rubber-Based Cable Sheathing Compounds, Thermal Analysis of Rubber Based Adhesives, Thermal Analysis of Rubber Based Insulators, Thermal Analysis of Thermal Interface Materials (TIM), Thermal Analysis of Automobile Tyres.	9	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	10	20	10	10	10

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

References/Suggested Learning Resources:

(a) Books:

1. Thermal Analysis of Rubbers and Rubbery Materials: Editors: Namita Roy Choudhury & Prajna P De and Naba K. Dutta.
2. Thermal Characterization of Polymeric Materials by EDITH A. TURI

(b) List of Open Source Software/learning website:

- http://www.crcpress.com
- http://pubs.acs.org/
- www.cjps.org/EN/article
- www.sciencedirect.com/

Suggested Course Practical List: If any

Practical based on above topics.

Suggested Project List:

1. Evolved Gas Analysis (EGA) in Thermal Decomposition of Rubbers
2. Dielectric Analysis (DEA) for Polarization in Rubbery Materials
3. Relaxation Map Analysis (RMA) for Crosslink Density Estimation
4. Morphological Analysis of Polymer Blends Using µTA
5. Characterization of Thin Rubber Films via Micro-Thermal Analysis
6. Micro-Sphere Thermal Characterization for Biomedical Applications
7. Nanostructure Characterization of Rubber Composites using µTA
8. Shape and Distribution Analysis of Fillers in Rubber Compounds
9. Thermal Stability Analysis of Rubber-Based Vibration Control Devices
10. Thermal Analysis of Thermal Interface Materials (TIM) in Electronics

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