GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Rubber Technology

Subject Code: ME02088081

Subject Name : Shape Memory Polymers: Fundamentals, Advances & Applications

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

Prerequisite:	Basic knowledge of rubber technology, Structure-Property Relationships & Fundamentals of Polymers and material science.
Rationale:	The study of Shape-Memory Polymers (SMPs) and their composites represents a vital area of research in material science and engineering due to their transformative applications across various domains. This rationale outlines the necessity and significance of the proposed framework for exploring SMPs, emphasizing their intrinsic properties, molecular design, and practical implementations. The proposed structure offers a systematic and exhaustive exploration of SMPs, integrating fundamental science with advanced engineering applications. This approach ensures the development of innovative materials that meet diverse industrial needs, laying the groundwork for future research and applications in shape-memory materials.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Explain the basics, effects, and classification of SMPs and their mechanisms.
C02	Analyze molecular design and phase-based functionalities of SMPs.
C03	Evaluate SMP composites, blends, and network properties.
C04	Develop models to predict SMP behavior and device applications.
C05	Design SMP applications in engineering, textiles, and smart systems.

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.	**Shape-memory Polymers:** Introduction, its effect, its effect in Shape-memory Polymers and Shape-memory Alloys, Structure, Thermally Induced Shape-memory Polymers, Athermal Shape-memory Polymers, Classification of Shape-memory Polymers.	5	10
2.	**Molecular Design, Shape-memory Functionality and Programming:** Introduction, Molecular Design of Shape-memory Polymers, Thermally Sensitive Shape-memory Polymers, Shape-memory Polymers based on the Amorphous Phase and Semi-crystalline Phase, Shape-memory Polymers based on Liquid Crystalline Phase, Photosensitive Shape-memory Polymers, Other Molecular Architectures of Shape-memory Polymers	6	15
3.	**Shape-memory Polymer Composites:** Introduction, Nanowhisker/Shape-memory Polymer Composites, Carbon/Shape-memory Polymer Composites, Fibre/Fabric-reinforced Shape-memory Polymer Composites, Metal and Metal Oxides/Shape-memory Polymer Composites, Other Shape-memory Polymer Composites,	5	10
4.	**Shape-memory Polymer Blends:** Introduction, Miscible Polymer Blends, Immiscible Polymer Blends, Elastomer/Polymer Blends, Other Types of Immiscible Blends, Blending and Post-crosslinking Polymers Networks, Interpenetrating Polymer Networks, Crosslinked Polymer Blends	6	15
5.	**Shape-memory Polymers Sensitive to Different Stimuli:** Introduction, thermally sensitive Shape-memory Polymers, Light-sensitive Shape-memory Polymers, Magnetic-sensitive Shape-memory Polymers, Water/solvent-sensitive Shape-memory Polymers, Electric-sensitive Shape-memory Polymers	5	15
6.	**Modelling of Shape-memory Polymers:** Introduction, Macroscale Constitutive Modelling, Mesoscale Modelling, Microscale Modelling, Molecular Dynamics and Monte Carlo Simulations, Mathematical Modelling, Modelling of Device Structures, Modelling for Light-sensitive Shape-memory Polymers,	6	15
7.	**Supramolecular Shape-memory Polymers:** Introduction, Supramolecular Chemistry, Polymers Containing Pyridine Moieties: a Pathway to Achieve Supramolecular Networks, Supramolecular Shape-memory Polymers based on Pyridine Moieties, Cyclodextrins, Potential Applications,	6	10

8.	**Applications of Shape-memory Polymers:** Introduction, Applications of Bulk Shape-memory Polymers, Applications in Surface Wrinkling and Patterning, Applications in Textiles, Engineering Applications like Transportation., Sensors and Actuators, Filtration, Insulation	6	10
	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. Shape Memory Polymers: Fundamentals, Advances and Applications **by** Jinlian Hu

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

- **https://ocw.mit.edu/**
- **https://www.sciencedirect.com/**
- **https://www.edx.org/**

Suggested Course Practical List: If any

Practical based on above topics.

Suggested Project List:

1. Study of Thermally Induced and Athermal Shape-Memory Polymers
2. Molecular Design of Thermally Sensitive Shape-Memory Polymers
3. Design and Characterization of Photosensitive Shape-Memory Polymers
4. Characterization of Fiber/Fabric-Reinforced Shape-Memory Polymer Composites
5. Study of Miscible and Immiscible Polymer Blends for Shape-Memory Applications
6. Development of Light-Sensitive Shape-Memory Polymers for Smart Textiles

7. Magnetic-Sensitive Shape-Memory Polymers for Actuator Applications
8. Development of Supramolecular Shape-Memory Polymers Based on Pyridine Moieties
9. Shape-Memory Polymers for Smart Textiles and Wearable Technology
10. Shape-Memory Polymers for Aerospace and Engineering Applications

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