GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME03088021
Subject Name : Short Fiber Polymer Composites

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	MOPEC

Prerequisite:	Basic knowledge of rubber technology different types of textiles, their structure and properties, processing techniques for rubber and textiles and compounding ingredients.
Rationale:	The study of short fiber polymer composites is essential for advancing materials engineering and sustainable development. This rationale justifies the structured exploration of short fiber composites, covering fundamental concepts, processing techniques, mechanical properties, characterization methods, computational modeling, industrial applications, and sustainability aspects. Environmental concerns drive the need for sustainable composite materials. This course discusses eco-friendly short fiber composites, including bio-based polymers and natural fibers. The challenges of recycling short fiber composites through mechanical and chemical processes are addressed. The environmental impact, end-of-life considerations, and future perspectives on sustainable composite materials are also examined to promote the development of green composites. The insights gained from this study will contribute to the optimization and innovation of short fiber composite materials for future engineering solutions.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Understand the fundamental concepts of polymer composites, including their types, classifications, and applications in various industries.
C02	Analyze the characteristics and properties of short fibers, their interaction with matrices, and the effects of fiber orientation and distribution on composite performance.
C03	Evaluate various processing techniques for short fiber polymer composites and address challenges in fiber dispersion, alignment, and bonding.
C04	Assess the mechanical properties (tensile, flexural, impact) and thermal behavior of short fiber composites and the role of fiber content and length distribution in determining material properties.
C05	Apply characterization techniques and modeling approaches (FEA, micromechanics) for predicting the performance and behavior of short fiber polymer composites in industrial applications.

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	00	03	70	30	00	00	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Polymer Composites:** Definition and classification of composites, Types of fibers: short fibers, continuous fibers, natural fibers, synthetic fibers, Matrix materials: thermosets and thermoplastics, Advantages of fiber reinforcement in polymers, Applications of fiber-reinforced polymer composites	6	10
2.	**Short Fibers in Composites:** Characteristics of short fibers, Fiber length, aspect ratio, and their effects on composite properties, Fiber-matrix interface: interfacial bonding and adhesion mechanisms, Comparison of short fibers with long fibers in polymer composites, Influence of fiber orientation and distribution on mechanical properties.	5	10
3.	**Processing Techniques for Short Fiber Polymer Composites:** Molding techniques: Injection molding, compression molding, and extrusion, Filament winding and pultrusion for short fiber composites, Methods for achieving fiber dispersion in matrix material, Role of fiber sizing and surface treatments in processing, Processing challenges: fiber breakage, alignment, and matrix-fiber bonding.	5	10
4.	**Mechanical Properties of Short Fiber Polymer Composites:** Tensile, flexural, and impact properties of short fiber composites, Creep and fatigue behavior, Thermal properties: Thermal stability, conductivity, and expansion, Influence of fiber content and fiber length distribution on mechanical properties, Characterization of strength and stiffness in short fiber composites	5	15
5.	**Characterization Techniques:**	6	15

	Microscopic and morphological analysis: SEM, TEM, and optical microscopy, Mechanical testing: Tensile, compression, flexural, and impact testing, Rheological measurements for flow behavior in processing, X-ray diffraction and FTIR for fiber-matrix interaction studies, Acoustic emission and ultrasonic testing for damage analysis		
6.	**Modeling and Simulation of Short Fiber Composites:** Micromechanics models for predicting composite behavior (Halpin-Tsai, Mori-Tanaka), Finite Element Analysis (FEA) for simulating short fiber composite performance, Modeling fiber-matrix interactions and fiber orientation effects, Computational tools for designing short fiber composite materials, Homogenization techniques for effective material properties prediction.	6	15
7.	**Industrial Applications of Short Fiber Composites:** Automotive applications: Lightweight structures, interior components, and under-the-hood parts, Aerospace applications: Structural components and advanced composites, Construction and civil engineering: Short fiber composites for structural reinforcement, Consumer goods: Packaging, electronics, and sports equipment, Challenges and future trends in industrial applications	6	15
8.	**Sustainability and Recycling of Short Fiber Composites:** Eco-friendly short fiber composites: Bio-based polymers and natural fibers, Challenges in recycling short fiber composites: Mechanical recycling, chemical recycling, and upcycling, Environmental impact of short fiber composites, End-of-life considerations for short fiber reinforced polymer products, Future perspectives on sustainable composite materials.	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:

Recommended Textbooks:

1. "Polymer Composites: Science and Technology" by Mallick, P. K.
2. "Composite Materials: Science and Engineering" by Krishan K. Chawla
3. "Handbook of Composite Materials" by L. M. Turner, S. P. Joshi, S. M. Shuford
4. "Short Fiber Reinforced Polymer Composites" by J. M. Reifsnider
5. "Fundamentals of Polymer Composites" by B. K. M. H. Pour

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

- **https://www.rheocomp.com/intro.php**
- **https://www.simscale.com/**
- **https://www.nzymes.com/**
- **https://www.recyclablepolymers.com/**

Suggested Course Practical List: If any

1. Design and Fabrication of Polymer Composite Samples Using Natural and Synthetic Fibers
2. Comparative Study of Fiber-Reinforced Polymer Composites for Structural Applications
3. Fiber-Matrix Interface: Interfacial Bonding and Adhesion Mechanisms
4. Optimizing Fiber Dispersion in Matrix Materials during Injection Moldin
5. Role of Surface Treatments and Fiber Sizing in Enhancing Matrix-Fiber Bonding
6. Microscopic Analysis of Short Fiber Reinforced Composites Using SEM and TEM
7. Micromechanics Models for Predicting the Behavior of Short Fiber Composites
8. Finite Element Analysis (FEA) Simulation of Fiber-Matrix Interactions in Short Fiber Composites
9. Design of Lightweight Structural Components for Automotive Applications Using Short Fiber Composites
10. Development of Eco-friendly Short Fiber Composites Using Bio-based Polymers
11. Challenges in Recycling Short Fiber Composites: Mechanical and Chemical Recycling Techniques
12. Application of Short Fiber Composites for Structural Reinforcement in Civil Engineering
13. Thermal Stability and Conductivity of Short Fiber Composites: A Comparative Study
14. Investigation of the Effect of Fiber Length and Aspect Ratio on Composite Properties

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