GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME02000501

Subject Name: Composite Materials

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

Prerequisite:	Nil
Rationale:	To equip the students with the necessary theoretical knowledge and practical skills, this subject prepares them for advanced research, innovation, and industrial applications in the field of composite materials.

Course Outcome:

After Completion of the Course, the students will able to:

No	Course Outcomes	RBT level
1	To provide an in-depth understanding of the structure, properties, and applications of composite materials.	
2	Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application	
3	To explore advanced manufacturing techniques and characterization methods.	
4	To develop the ability to analyse and design composite structures for engineering 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)	
3	0	2	4	70	30	30	20	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to composite materials:** Definition, Classification of composites, Types of Reinforcements; Fibers (glass, carbon, aramid, natural fibers); Particulates and Whiskers, Types of matrices; Polymer, metal, ceramic, and carbon	10	24

	matrices. Comparison of composites with conventional materials. Characteristics & selection, Fibre composites, Laminated composites, particulate composites, sandwich construction. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. Advantages & limitations, applications of composites in aerospace, automotive, marine, and biomedical fields..		
2.	**Manufacturing, Testing and Characterization:** Layup and curing - open and closed mould processing, Hand lay-up techniques, filament winding, pultrusion, resin transfer molding (RTM), and vacuum bagging. Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. Mechanical testing: Tensile, compressive, shear, and impact tests. Types of defects, Thermal and dynamic testing: Thermo-Gravimetric analysis (TGA), Differential Scanning Calorimetry (DSC). Non-destructive evaluation (NDE): Ultrasonic testing, radiography, and acoustic emission, Acoustic ultrasonic method.	13	28
3.	**Fabrication of Composites:** Cutting, machining, drilling, mechanical fasteners & adhesive bonding joining computer aided design manufacturing tooling fabrication equipment. **Design of Fibre Reinforced Composite structures:** Modes of failure: Matrix cracking, delamination, fiber breakage. Introduction to Lamina and laminate theory, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners, forming dies, Dies for die casting and forging operations.	11	24
4.	**Application developments**: Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites. **Metal matrix composites:** Reinforcement materials, types, Characteristics & Selection, base metals-selection, applications. Powder metallurgy technique, liquid metallurgy technique	11	24
	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	**20**	**20**	**20**	**20**	**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. "Composite Materials: Science and Engineering" by Krishan K. Chawla.
2. "Mechanics of Composite Materials" by Autar K.Kaw - CRC Press New York - 1st edition, 1997.
3. "Principles of Composite Material Mechanics" by Ronald F. Gibson.

Reference Books:

1. "Composite Materials Handbook" by- Mein Schwartz - Mc Graw Hill Book Company - 1984.
2. "Introduction to Composite Materials Design" by Ever J. Barbero.
3. "Analysis and Performance of Fiber Composites" by B. D. Agarwal and L. J. Broutman.
4. Recent journal articles from Composites Science and Technology and Journal of Composite Materials.
5. Hand Book of Composite Materials by Ed-Lubin
3. Composite Materials Science and Applications – Deborah D.L. Chung
4. Composite Materials Design & Applications, CRC press, Danial Gay, Suong V. Hoa, & Stephen W. Tsai.

Suggested Course Practical List:

(A) Experiments:

1. Fabrication of laminates using hand lay-up and vacuum bagging.
2. Mechanical testing of composite samples (tensile, flexural, and impact tests).
3. Thermal analysis using Thermogravimetric analysis (TGA) and Differential Scanning Calorimetry (DSC).
4. Microstructural analysis using SEM/ Case studies based on Microstructural analysis from recently published selected research papers.

(B) Simulations:

1. Finite element modeling of composite structures using software like ANSYS, Abaqus, or HyperWorks.
2. Simulations of various failure modes in composites.
3. Multiscale modeling of composite materials.

List of Laboratory/Learning Resources Required:

Software manuals:

ANSYS Composite Prep Post.
MATLAB for composite analysis.

Suggested Activities for Students:

Project Work:

Design and analysis of a composite structure for a specific application.
Study of the environmental impact of composite materials.
Development of sustainable or bio-composites, and any other relevant project work.

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