GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Metallurgy Engineering

Subject Code : DI04021091

Subject Name : Composite Materials

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	MOPEC

Prerequisite:	A basic understanding of different types of materials, their properties, structure-property relationship, strengthening mechanisms, various manufacturing techniques, and testing methods.
Rationale:	As technical advancements in modern world impose stringent demands on materials to possess versatile properties, conventional materials often face limitations to meet these demands. Combination of two different materials i.e. composite materials offer tailor made set of properties to fulfill wide variety of service requirements hence playing a vital role in modern engineering applications. A metallurgical or materials engineer must possess a basic understanding of composite materials – their importance, classification, constituents, rule of mixture, interface, strengthening mechanisms and fabrication methods. This syllabus is designed to provide primary knowledge of composite materials to diploma students which will aid their skills to select an appropriate material for a particular application.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Classify composites and identify their need, advantages, as well as limitations over other conventional materials.	R
02	Differentiate between various reinforcements in composites in terms of their properties and applications.	U, A
03	Differentiate between popular polymer matrix composites, metal matrix composites, ceramic matrix composites, hybrid, and laminated composites in terms of their fabrication methods, properties, and applications.	U, A
04	Explain the interface and micromechanics of composites.	U
05	Explain the properties and applications of advanced composites including green and nano composites.	U

**Revised Bloom's Taxonomy (RBT)*

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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(M)	PA(I)	ESE (V)	
3	0	0	3	70	30	00	00	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Introduction to composite materials** 1.1 Definition of composite materials 1.2 Need and importance of composites 1.3 Matrix and reinforcements – definition, types and role in composites 1.4 Classification on the basis of matrix and reinforcements 1.5 Advantages and limitations of composites over other materials 1.6 Properties and applications of composite materials	05	10 %
2.	**Reinforcements** 2.1 Function and desirable characteristics of reinforcements 2.2 Classification of Reinforcements 2.3 Structure, properties and applications of different reinforcing fibers - glass fibers, carbon fibers, Kevlar aramid fibers and boron fibers 2.4 Properties and applications of whiskers 2.5 Properties and applications of particulate reinforcements – silicon carbide and tungsten carbide	06	14 %
3.	**Polymer Matrix Composites and Metal Matrix Composites** 3.1 Polymer matrix composites (PMC) 3.1.1 Matrix Materials and their properties: Thermoset - Epoxy, Polyester; Thermoplastic - Nylon, Polypropylene 3.1.2 Manufacturing methods: Hand Lay-up, Spray Lay-up, Filament Winding, Pultrusion, Injection Moulding. 3.1.3 Properties and Applications of PMCs 3.1.4 Fiberglass and Carbon Fiber Reinforced Polymer (CFRP) 3.2 Metal Matrix Composites (MMC) 3.2.1 Matrix Materials and their properties: Aluminium, Magnesium, Titanium, Copper alloys 3.2.2 Manufacturing Methods: Diffusion Bonding, Liquid Metal Infiltration, Squeeze Casting 3.2.3 Properties & Applications of MMCs 3.2.4 Aluminum matrix composites	10	24 %

4.	**Ceramic Matrix Composites and Other composites** 4.1 Ceramic Matrix Composites (CMC) 4.1.1. Matrix Materials and their properties: Al_2O_3, SiC, Si_3N_4 4.1.2 Manufacturing methods: Liquid Infiltration, chemical vapor impregnation (CVI) 4.1.3 Properties and Applications of CMCs 4.1.4 Carbon-Carbon Composites 4.2 Hybrid Composites: Definition and examples 4.3 Laminated Composites and Sandwich Panels: Basic structure, properties, and applications	08	16 %
5.	**Interface and micromechanics of composites** 5.1 Role and importance of the fiber-matrix interface and interphase 5.2 Wettability 5.3 Types of bonding at the interface 5.4 Rule of mixture 5.5 Strengthening mechanism of composites 5.6 Aspect ratio, Influence of fiber length, Critical fiber length, Short vs. Continuous Fibers, Influence of Fiber Orientation and Concentration	10	24 %
6.	**Advanced Composite Materials** 6.1 Mechanical and thermal properties of composites 6.2 Applications of advanced composite materials 6.3 Environmental effects in composites 6.4 Green composites 6.5 Nano composites - Synthesis and properties	06	12 %
	Total	**45**	**100%**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**45**	**35**	**0**	**0**	**0**

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. K.K. Chawla, Composite Materials – Science & Engg., Springer- Veslag, New York, 1988. ISBN: 978-0-387-74364-6 for 3rd Ed., 2012
2. Composite Materials – Lensile – Holliday, Elsevie Publishing Company, Amsterdam.

3. Mel M. Schwartz, Composite Materials: Properties, Non-destructive testing and Repair, Prentice Hall, New Jersey, ISBN: 978-0-13-300047-4
4. L.J. Broutman and R.M. Krock, Modern Composite Materials, Addison-Wesley, 1967.
5. David A Colling & Thomas Vasilos, Industrial Materials: Polymers, Ceramics and Composites, vol. 2, Prentice Hall, N. Jersey, 1995, ISBN: 978-0-02-323553-5

(b) Open-source software and website:

1. https://nptel.ac.in/courses/112104229
2. https://nptel.ac.in/courses/112104221
3. https://www.coursera.org/learn/ceramics-and-composites
4. https://ocw.tudelft.nl/courses/advanced-design-optimization-composite-structures/
5. https://ocw.mit.edu/courses/3-11-mechanics-of-materials-fall-1999/

Additional suggested project list:

1. Select five hi-tech applications of composites and justify the preference of composites over conventional materials for those applications.
2. Compare the properties of polymer matrix composites reinforced with glass fibers, ceramic whiskers and particulates.
3. Draw flow charts of different fabrication methods of PMC, MMC and CMC.
4. Identify the need of laminated or sandwich panels composites.
5. Derive the rule of mixture equation and discuss its limitations in estimation of properties.
6. Prepare a report on influence of fiber length, orientation, and concentration on properties of a composite.
7. Select one composite from each type i.e. PMC, MMC and CMC and research on the type/s of interfacial bonding contributing in their strength.
8. Search any two examples of green composites and report their composition, fabrication method, properties, as well as uses.

Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should conduct following activities in group.

a) Visit a nearby industry manufacturing composites.
b) Visit a nearby testing laboratory conducting mechanical testing of composites.
c) Collect components made of composite materials from your surroundings.

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