

COURSE TITLE	MECHANICS AND MANUFACTURING OF COMPOSITES
COURSE CODE	01CA1313
COURSE CREDITS	3

Objective:

- 1 The course intends to introduce students to fundamentals of composite materials mechanics and manufacturing techniques.

Course Outcomes: After completion of this course, student will be able to:

- 1 Analyse the micromechanical behaviour of fibre-reinforced composite laminates under various loading conditions using appropriate failure criteria.
- 2 Evaluate manufacturing processes for composite materials — including moulding, filament winding, and pultrusion — to select optimal methods for given applications.
- 3 Apply classical laminate theory to design composite components for structural applications, accounting for stiffness, strength, and hydrothermal effects.
- 4 Analyse laminate stress-strain behaviour and perform failure analysis for symmetric, antisymmetric, and unsymmetrical laminate configurations.
- 5 Evaluate the static, fatigue, impact, and fracture performance of composites under varying environmental and loading conditions.

Pre-requisite of course: Solid Mechanics, Manufacturing Process

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	Basic concepts and characteristics Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites.	2
2	Constituents: Reinforcements & Matrix Materials Reinforcements: Fibers- Glass, Silica, Kevlar, carbon, graphite, boron, silicon carbide, and boron carbide fibers., Matrix Materials: Particulate composites, Polymer composites, Thermoplastics, Metal matrix and ceramic composites.	2

Contents : Unit	Topics	Contact Hours
3	Micromechanics Behavior Lamina Stress-strain behavior for anisotropic materials, stiffness, compliance and engineering constants for orthotropic materials, Stress-strain behavior for plane stress in an orthotropic material, Stress-strain behavior for lamina of arbitrary orientation, strength of an orthotropic lamina, Biaxial strength criteria for an orthotropic materials (Maximum stress, Maximum strain, Tsai- Hill, Hoffman, Tsai-Wu)	9
4	Micromechanical Behavior Lamina Determination of constants, Elasticity approach to stiffness, particulate composite, Fiber-reinforced composites, tensile and compressive strength in fiber direction, transverse stiffness and strength, prediction of shear strength, Failure modes process	7
5	Short-Fiber Composites Theories of Stress Transfer, Modulus and Strength of Short-Fiber Composites, Ribbon-Reinforced Composites	4
6	Analysis of Laminates Laminate Stress-Strains behavior, Variation of Stresses in a Laminate, Resultant Forces and Moments: Synthesis of Stiffness Matrix, Laminate Description System, Construction and Properties of Special Laminates, Determination of Laminate Stresses and Strains, Analysis of Laminates after Initial Failure, Hydrothermal Stresses in Laminates, Bending and Buckling of laminated plates, Special Cases: Symmetric, Anti symmetric and Unsymmetrical laminates. Design of laminates	9
7	Performance of Composites Static Mechanical Properties (Tensile, Compressive, Flexural, In-plane shear, Inter laminar shear strength), Fatigue performance, Impact properties, Environmental effects, Creep and Fracture behavior.	5
8	Manufacturing Degree of Cure, Viscosity, Resin Flow, Consolidation, Gel-Time Test, Shrinkage, Voids, molding methods, filament winding, pultrusion, Quality inspection. Joining: Pin bearing, adhesive bonding	6
Total Hours		44

Textbook :

- 1 Analysis and Performance of Fiber Composites, Agarwal, B.D. and Broutman, L. J., John Wiley & Sons, 2017
- 2 Fiber-Reinforced Composites Materials, Manufacturing and Design, Mallick P. K., CRC Press, 2007

References:

- 1 Mechanics of Composite Materials, Mechanics of Composite Materials, Jones R M, CRC Press, 1998
- 2 Engineering Mechanics of Composite Materials, Engineering Mechanics of Composite Materials, Daniel, I. M. and Ishai, O, Oxford University Press, 2006
- 3 Mechanics of Composite Materials, Mechanics of Composite Materials, Jones, R. M., McGraw Hill, 2018
- 4 Composite Materials Science and Engineering, Composite Materials Science and Engineering, Krishan K. Chawla, Springer, 2012
- 5 Composite Materials Mechanics, Manufacturing and Modeling, Composite Materials Mechanics, Manufacturing and Modeling, Sumit Sharma, CRC Press, 2021

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	10.00	20.00	15.00	25.00	20.00

Supplementary Resources:

- 1 nptel.ac.in