MECHANICS OF COMPOSITE MATERIALS
(Professional Elective - II)

I Semester

Course Code: 19ME2154

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Course Outcomes: At the end of the course, the student will be able to
CO1: Classify composites, types of reinforcement and matrix phases.
CO2: Determine stress and strain, elastic constants of composites.
CO3: Explain different fabrication methods to prepare composite materials.
CO4: Describe methods to characterize composite properties.
CO5: Analyse different types of composite laminates using thin plate theory.

UNIT-I **(10-Lectures)**

Introduction: Definition of composite material, classification based on matrix and topology, constituents of composites, interfaces and interphases, distribution of constituents, mechanical behavior of composite materials, nano composites, applications.
Raw materials: Resins: polyester, epoxy, metal matrices. Reinforcement: glass fibers, boron fibers, silicon carbide, carbon and graphite fibers, Kevlar, sisal and other vegetable fibers, whiskers, fillers and parting agents.
Learning outcomes:

1. List the different types of composite materials based on matrix and topology. (L1)
2. Explain the mechanical behavior of composite materials. (L2)
3. Identify the different types of fibers. (L1)

UNIT-II **(10-Lectures)**

Fabrication methods: Hand lay-up: molding, bag molding, mating molds, spray up molding, matched - die molding, perform molding, filament winding, winding patterns and winding machines, pultrusion, liquid composite molding.
Learning outcomes:

1. Explain the different types of fabrication methods. (L2)
2. Demonstrate the working principle of spray up molding. (L2)
3. Apply the liquid composite molding to various fibers. (L3)

UNIT-III **(10-Lectures)**

Micromechanics: Introduction, weight and volume fractions, properties of lamina, representative volume element.
Micromechanical behavior of Lamina: Stress- strain relation for anisotropic materials, stiffness, compliances, Engineering constants, restriction on engineering constants, stress strain relation for plane stress in orthotropic materials.
Learning outcomes:

1. Calculate the properties of lamina. (L3)
2. Apply the stress strain relation for anisotropic materials. (L3)
3. Determine the elastic constants of the composites. (L3)

UNIT-IV **(10-Lectures)**

Macromechanical behavior of laminates and plate theories: Elastic approach to stiffness, mechanics of materials approach to stiffness and strength, classical laminate theory, special cases of laminate stiffness, strength of laminates, inter laminar stresses.

Learning outcomes:

1. Demonstrate the elastic approach to stiffness. (L3)
2. Analyze the mechanics of materials approach to stiffness and strength. (L4)
3. Evaluate the strength of laminates. (L5)

UNIT-V **(10-Lectures)**

Strength of unidirectional lamina: Micromechanics of failure, failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear, maximum stress and strain criterion. Fiber composites: Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: single and multiple fracture, de-bonding, fibre pull out and de-lamination failure, fatigue of laminate composites, the failure envelope.

Learning outcomes:

1. Explain the micromechanics of failure. (L2)
2. Solve the simple problems on strength of an orthotropic lamina. (L3)
3. Analyze the fracture modes in composites. (L4)

TEXT BOOKS:

1. R.M. Jones, *Mechanics of Composite Materials*, Scripta Book company, Washington DC, 2nd Edition, 2011.
2. Madhujit Mukhopadhyay, *Mechanics of Composite Materials and Structures*, Universalities press, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Isaac and M Daniel, *Engineering Mechanics of Composite Materials*, Oxford University Press, 1994.
2. Autar K.Kaw, *Mechanics of Composite Materials*, CRC Publishers,1997.
3. B.D.Agarwal and L.J.Broutman, *Analysis and performance of Fibre Composites*,Wiley Interscience, Newyork, 1980.