# **MECHANICS OF COMPOSITE MATERIALS** (Professional Elective - II)

## Course Code: 19ME2154

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.

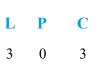
Learning outcomes:

- 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.



I Semester

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, 2<sup>nd</sup> Edition, 2011.
- 2. Madhujit Mukhopadhyay, *Mechanics of Composite Materials and Structures*, Universalities press, 2<sup>nd</sup> 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.