

## 20MD016 MECHANICS OF COMPOSITE MATERIALS

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### Course Description and objectives:

Composite materials are being increasingly used in engineering structures as load bearing elements. The main objective of this subject is to provide knowledge about stress distribution, calculation of stresses, stress transfer and failure theories associated with fiber reinforced composite laminates. The extent of the material science information required to reach this objective is also covered in the content.

### Course Outcomes:

Upon successful completion of the course student should be able to:

- Suggest the suitable type of composite materials for given applications.
- Acquire knowledge on failure theories used in composite analysis.
- Understand the reasons for hygro-thermal stresses and ways to minimize these stresses.
- Explain the damage progression in the laminate

### Skills Acquired:

- Acquire knowledge on laminates and the dependence of laminate properties on stacking sequence.
- Laminate strength calculation.
- Estimation of the variation of the laminate elastic/strength
- Characterization of the lamina and laminate.

### UNIT-I

**Analysis of Orthotropic materials:** Hooke's law for orthotropic materials, relations between engineering constants and elements of stiffness and compliance matrices, restrictions on elastic constants, stress strain relations for lamina with arbitrary orientation, transformation of engineering constants

### UNIT-II

**Macro-mechanical Analysis of a Lamina:** Classification and Types of composite materials Laminae and Laminate, deformation of unidirectional lamina, Hooke's law for different types of materials: Anisotropic, Monoclinic, Orthotropic material, Hookes law for a 2D unidirectional lamina

### UNIT-III

**Micromechanicala analysis of a Lamina:** Volume and mass fractiona, density and void content, evaluation of four elastic moduli, elasticity approach, hygrothermal effects

#### **UNIT-IV**

**Failure analysis of Laminates:** Stress analysis and safety factors for first – ply failure of laminates, computational procedure for stress and failure analysis of general multidirectional laminates, hygrothermal stresses micromechanics of progressive failure, stiffness reduction, ultimate laminate failure, inter laminar stresses, edge effects.

#### **UNIT-V**

**Experimental methods for Characterization and Testing:** Characterization of constituent materials, Physical characterization of composite materials, Determination of tensile, compressive, interlaminar strength and interlaminar fracture toughness

#### **TEXT BOOKS:**

1. Isaac and M Daniel, “Engineering Mechanics of Composite Materials”, 2nd Edition, Oxford University Press, 2006.

#### **REFERENCE BOOKS:**

1. B.D. Agarwal and L.J.Broutman, “Analysis and performance of fibre Composites”, 3rd Edition, Wiley - Inter science New York, 2006.
2. Autar K. Kaw, “Mechanics of Composite Materials”, 2<sup>nd</sup> Edition, CRC press, USA, 2006