

**B.TECH – Mechanical Engineering**  
**Course Type: Elective**  
**Course Instructor: Satadru Kashyap**

Course Code	Course Name	Lecture	Tutorial	Practical	Credit
ME 434	COMPOSITE MATERIALS	3	0	0	3

### **COURSE DESCRIPTION:**

This course is designed for B.Tech students as an introductory course in building foundational knowledge in ‘composite materials’. It introduces the concepts of: (i) definition, characterization and classification of composites, (ii) methods of composite strengthening and manufacturing, and (iii) Mechanics and mechanical performance of composites under loading.

### **COURSE OBJECTIVES**

This course is designed as an introductory course on “Composite Materials”. The course objectives are to

- Train students on composite materials – definition, advantages and classification.
- Equip students with knowledge on composite strengthening addition of components and their production routes.
- Familiarize students about the properties and response of composite structures subjected to mechanical loading.

### **COURSE OUTCOMES**

Upon successful completion of the students will be able to:

- CO1: Identify and understand the basic mechanical behaviour of composite materials and make sound prediction on the likely behaviour of new combinations of materials.
- CO2: Apply the choices made for using certain types of composites in certain applications with reference to composite properties.
- CO3: Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behaviour, where appropriate.
- CO4: Analyse the micromechanical properties of fibre reinforced composites.

### **COURSE SYLLABUS**

#### **UNIT I**

**Introduction:** Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.

## UNIT II

**Reinforcements Materials:** Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Non-woven random mats.

**Types of matrix:** Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Inter-metallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.

## UNIT III

### Production techniques and Properties:

Processing of cast composites - XD process, Spray processes (Osprey Process, Rapid solidification processing), In-situ Dispersion Processes (Stir-casting & Compo casting, Screw extrusion), Liquid-metal impregnation technique (Squeeze casting, Pressure infiltration, Lanxide process).

Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.

## UNIT IV

**Mechanics of Composite Materials:** Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials.

**Mechanical Properties:** Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.

## UNIT V

**Recent developments in Composites:** Self healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).

### Lecture plan:

No.	Tentative lectures	Topics
1	1-5	<b>UNIT I</b> <b>Introduction:</b> Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.
2	6-11	<b>UNIT II</b> <b>Reinforcements Materials:</b> Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites. Reinforcement fibres, Woven fabrics and Non-woven random mats. <b>Types of matrix:</b> Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Inter-metallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.

3	12 -20	<p><b>UNIT III</b></p> <p><b>Production techniques and Properties:</b>  Processing of cast composites - XD process, Spray processes (Osprey Process, Rapid solidification processing), In-situ Dispersion Processes (Stir-casting &amp; Compo casting, Screw extrusion), Liquid-metal impregnation technique (Squeeze casting, Pressure infiltration, Lanxide process).  Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.</p>
4	21-33	<p><b>UNIT IV</b></p> <p><b>Mechanics of Composite Materials:</b> Continuous fibres – iso-stress and iso- strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials.  <b>Mechanical Properties:</b> Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.</p>
5	34-39	<p><b>UNIT V</b></p> <p><b>Recent developments in Composites:</b> Self healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).</p>

**Evaluation Plan:**

Test No.	Marks	Duration
I	10	45 min
II (Mid term)	30	2 hours
III	10	Assignment (type)
IV (End term)	50	3 hours
Total	100	

**Text books:**

- Chawla K.K., Composite materials, Springer, New York, 1998.

**Reference books:**

- Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.
- Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
- Sharma S.C., Composite materials, Narosa Publications, 2000.

- Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.