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	**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.
2	6-11	**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.
3	12 -20	**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.

4	21-33	**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.
5	34-39	**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).

Evaluation Plan:

Test No.	**Marks**	**Duration**
I	20	45 min
II (Mid term)	20	45 min
III	20	Assignment (type)
IV (End term)	40	2 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.