COMPOSITE MATERIALS FOR STRUCTURAL ENGINEERING

I Semester: ST								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BSTC06	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

Composite materials such as fiber-reinforced composites, aggregate composites, and natural fiber reinforced composites have been used widely in engineering structures in various industries. Composite laminates, especially fiber reinforced metal laminates (FRMLs) have been used extensively in aerospace structures. Composite laminates are materials that involve some combination on a macroscopic scale of two or more different primary structural engineering constituents such as polymers, metals, ceramics and glasses. This book presents current research from across the globe in the study of composite materials, including the effects of thermo-oxidation on composite materials and structures at high temperatures; damping in composite materials; fatigue and fracture of short fiber composites; and solutions for post buckling of composite beams.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The fundamental properties of composite materials for identifying material quality.
II. The importance of stresses and strains relation in composites materials for efficient design of composite structures.
III. The mechanical behavior of glass fibre-reinforced laminates in structural stiffening.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:		
CO 1	Explain the mechanical behavior of layered composites compared to isotropic materials.	Understand
CO 2	Apply constitutive equations of composite materials	Apply
CO 3	Explain the mechanical behavior at micro and macro levels	Understand
CO 4	Determine stresses and strains relation in composites materials.	Evaluate
CO 5	Identify, properties of fibre reinforcements, polymer matrix materials and commercial composites.	Apply
CO 6	Analyze and design the various special concrete structures.	Analyze

IV.SYLLABUS:

MODULE-I: COMPOSITE MATERIALS (09)

Introduction: Requirements of structural materials, influence of nature of materials in structural form, Nature of structural materials- Homogeneous materials, composite materials.

MODULE-II: MACRO MECHANICAL PROPERTIES OF COMPOSITE LAMINAE (09)

Introduction, assumptions and idealizations, stress strain relationships for composite laminate, isotropic, orthotropic laminate, strength characteristics, basic concepts, strength hypothesis for isotropic

and orthotropic laminate. Macro mechanical analysis of composite laminate: Introduction, assumptions and limitations, stiffness characteristics of glass reinforced laminate, stress- strain relationships in continuous, discontinuous fibre laminate, strength characteristics of glass reinforced laminate, strengths in continuous, discontinuous fibre laminate.

MODULE-III: BEHAVIOUR OF GLASS FIBRE-REINFORCED LAMINATES
(09) Introduction, stiffness characteristics of laminated composites, behavior of laminated beams and plates, strength characteristics of laminated composites, strength analysis and failure criteria, effect of inter laminar structures.

Glass reinforced composites: Introduction, continuously reinforced laminates, uni-directionally and multi directionally continuously reinforced laminates, discontinuously reinforced laminates, stiffness and strength properties.

MODULE-IV: GRP PROPERTIES RELEVANT TO STRUCTURAL DESIGN (09)
Glass reinforced plastics (GRP): Introduction, short-term strength and stiffness-tensile, compressive flexural and shearing. Long term strength and stiffness properties, temperature effects, effect of fire structural joints- adhesive, mechanical, combinational, transformed sections.

MODULE-V: DESIGN OF GRP BOX BEAMS (09)
Introduction, loading, span and cross-sectional shape, selection of material, beam manufacture, beam stresses, experimental behaviour, effect on beam performance, modulus of elasticity, compressive strength, I value, prevention of compression buckling failure, behaviour under long term loading. Design of stressed skinned roof structure: Introduction, loading and material properties, preliminary design, and computer analysis.

V.TEXT BOOKS:

1. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, “Analysis and performance of fiber composites”, John Wiley & Sons, Australia, Limited, 1980.
2. Isaac M. Daniel, OriIshai, “Engineering mechanics of composite materials”, Oxford University Press Volume 13, 2006.

VI.REFERENCE BOOKS:

1. M. Holmes & J. Just, “GRP in Structural Engineering”, Applied science publisher Ltd, 1983.
2. Manjunath Mukhopadhyay, “Mechanics of composite materials and structures”, Universities Press, 2005.

VII. WEB REFERENCES:

1. http://nptel.ac.in/courses/112104168/L14.pdf

VIII. E-TEXT BOOKS:

1. https://www.amazon.com/Analysis-Performance-Composites-Bhagwan-Agarwal/dp/0471268917