Course Code	Course Title	L	T	P	C
20SE021	FIBER REINFORCED POLYMERS	3	0	0	3

PRE-REQUISITE COURSES: Advanced Concrete Technology

COURSE OBJECTIVES:

The main objective of the course is to understand about FRP concrete, material characteristics of FRP bars, failure modes for FRP, design of RC Structures Reinforced with FRP Bars and usage of FRP as retrofitting and repair material.

COURSE OUTCOMES:

At the end of the course student will be able

CO's	Course Outcomes	PO's
1	Understand the concept of FRP concrete	1
2	Understand Material Characteristics of FRP Bars	1
3	Understand Modes of failure for FRP	1
4	Apprehend the knowledge of design of RC Structures Reinforced with FRP Bars	3
5	Understand the usage of FRP as retrofitting and repair material	5

SKILLS:

- ✓ To understand the basic concept of FRP.
- ✓ To understand the characteristics of FRP composite materials as well as the latest manufacturing techniques.
- ✓ Ability to identify the failure modes in FRP.
- ✓ To understand design procedures for the use of fiber-reinforced polymer (FRP) materials for reinforcement.
- ✓ Ability to use FRP as retrofitting and repair material.

UNIT-I:

INTRODUCTION: Evolution of FRP Reinforcement, Importance of the Polymer Matrix, Description of Fibers-Carbon, Basalt, Glass, PBO, Natural fibers; Manufacturing and Processing of Composites, Sandwich Construction, Compression Molding, Multi-Axial Fabric for Structural Components, Fabrication of Stirrups, FRP Composites, History and uses of FRP Technology.

UNIT-II:

MATERIAL CHARACTERISTICS: Physical and Mechanical Properties, Physical Properties, Mechanical Properties and Behavior-Tensile behavior, Compressive behavior, Shear behavior, Bond behavior; Time-Dependent Behavior-Creep rupture, Fatigue, Durability, Recommended Materials and Construction Practices-Strength and modulus grades of FRP bars, Surface geometry, bar sizes, and bar identification

UNIT III:

MODES OF FAILURE: Bonding mechanism between FRP and concrete, Failure modes in FRP composites-breaking of fibers, Fiber pullout and debonding; Micro cracking of Matrix, Delamination-interlaminar, intralaminar, translaminar; Slippage of fibers, Development of bond stress, Bond slip models for various FRP composite systems.

UNIT-IV:

DESIGN OF RC STRUCTURES REINFORCED: Design Philosophy, Design material properties, Flexural and Shear design philosophy, Strength reduction factors for flexure and shear, Serviceability requirements.

UNIT-V:

RETROFITTING AND REPAIR MATERIAL: Introduction, Strengthening Methods of retrofitting using FRP composites-externally bonding technique, FRP wrapping of columns, beams, slabs etc; NSM strengthening technique using epoxy adhesive, textile reinforced mortars.

TEXT BOOKS:

1. Shamsher Bahadur Singh, Analysis and Design of FRP Reinforced Concrete Structures, McGraw - Hill, 2015.
2. GangaRao, Hota VS, Narendra Taly, and P. V. Vijay, Reinforced concrete design with FRP composites, CRC press, 2006.
3. G Lubin, “Hand Book of Composites”, 2nd Ed, Van Nostrand Reinhold, New York,1982.
4. L.Holloway “Hand Book of Composites for Engineers”, Technomic, Lancaster, Pa, 1994.

REFERENCES:

1. Hensher, David A, Fiber-reinforced-plastic (FRP) reinforcement for concrete structures: properties and applications, Elsevier, 2016.
2. Nanni, Antonio, and C. W. Dolan. "Fibre-Reinforced-Plastic (FRP) Reinforcement for Concrete Structures." Properties and Application, Developments in Civil Engineering. 248p (1993).
3. S.M. Lee, “Dictionary of Composites Materials Technology”, Technomic Lancaster,Pa, 1989.

4. G.Shook, “Reinforced Plastic for Commercial Composites”, Source Book, Asm, 1986.
5. Kevin Potter, “An Introduction to Composites Products”, Chapman and Hall Madras India 1997
6. S.T.Peter, “Hand Book of Composites”, Chapman and Hall Chennai 1998.
7. Lin / Pearce, “High Performance Thermosets”, Hanser Publishers, Munich, New York, 1993.
8. Harold Belofsky, “Plastics: Product Design And Process Engineering”, Hansen Publisher Munich, New York, 1995,