Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-1

Subject: Theory and applications of cement composites– METSE11504

Type of course: Minor Stream

Prerequisite: Material Science, Concrete Technology, Mechanics of Structures

Rationale: Concrete, being a traditional composite material, has earned a reputation for its exceptional strength and versatility. While it excels in compression, high strength concrete can be susceptible to brittleness. To address this limitation and improve its long-term performance under challenging environmental and structural conditions, concrete is now subject to modifications, achieved through cement and concrete composites. These composites incorporate binders or matrices that effectively unite various fibers or fragments, tailored to specific needs. The resulting composite product is lightweight, robust, flexible, and significantly more efficient when compared to conventional concrete composites.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	1	0	5	60	30	10	20	30	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Mechanical Behavior and Stiffness of Composite Materials** Students will select a composite material and use both the mechanics of materials approach and the elasticity approach (including Halpin-Tsai equations) to calculate stiffness. They will compare these methods, discussing the accuracy and applicability of each approach for different composite materials. A report detailing their findings, calculations, and comparative analysis will be submitted on the GMIU Web Portal.	10

2	**Mechanical Properties of Cement Composites** Students will conduct experimental or simulation-based studies to analyze the behavior of ferrocement and fibre-reinforced concrete under various loading conditions. They will focus on key properties such as tensile strength, compressive strength, flexural strength, shear capacity, fatigue resistance, and impact toughness. They will also evaluate durability and resistance to corrosion. Students will compile their results and submit a detailed report on the GMIU Web Portal.	10
3	**Applications of Cement Composites in Construction** Students will select a specific application (e.g., a water storage tank or a housing unit) and design a structural element using FRC or ferrocement. They will analyze the structural behavior using appropriate constitutive relationships and elastic constants, focusing on orthotropic and anisotropic behavior. The students will prepare a design report, including structural analysis, detailing, and material selection, which will be submitted on the GMIU Web Portal.	10
Total		**30**

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Introduction** Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina	13	20
2	**Mechanical Behaviour** Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.	13	20
3	**Cement Composites** Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferrocement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.	10	15
4	**Mechanical Properties of Cement Composites** Behavior of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.	10	15
5	**Application of Cement Composites** FRC and Ferrocement- Housing, Water Storage, Boats	14	30

	and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants. **Analysis and Design of Cement Composite Structural Elements** Ferrocement, SIFCON and Fibre Reinforced Concrete.		
	Total	**60**	**100**

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	NA	NA	NA	NA	NA	NA

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and Fibre Reinforced Concrete - by understanding their strain- stress behaviour.
CO2	Classify the materials as per orthotropic and anisotropic behaviour.
CO3	Estimate strain constants using theories applicable to composite materials.
CO4	Analyze and design structural elements made of cement composites.
CO5	Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and FibreReinforced Concrete - by understanding their strain- stress behaviour.

List of Practical

Sr. No	Descriptions	Unit No	Hrs
1	Study the changes in the mechanical properties of Fiber reinforcedconcrete by varying % content of fibers	2	2
2	Investigation of the change in the mechanical properties of theFiber reinforced concrete due to variation in geometry of fibers	2	2
3	Experimental study of Effect of size and aspect ratio of fibers on properties of concrete	3	2

4	Experimental investigation to study tensile properties of Normal and Fiber reinforced concrete	4	2
5	Experimental study on effect of addition of fibers on Pull-Off strength of concrete	5	2
6	Study of cracking pattern of reinforced beams made up of (i) Normal Concrete (ii) Fiber reinforced concrete (iii) Ferrocement wrap under bending.s	5	2
		Total	**12**

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of the tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.
Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Mechanics of Composite Materials, Jones R. M,, 2nd Ed., Taylor and Francis,BSP Books, 1998.
[2] Ferrocement – Theory and Applications, Pama R. P., IFIC, 1980.
[3] New Concrete Materials, Swamy R.N., 1stEd., Blackie, Academic and Professional, Chapman & Hall, 1983
[4] Stress Analysis of Fiber-Reinforced Composite Materials, Michael W. Hyer, WCB/McGraw-Hill,Singapore.