INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVILENGINEERING

COURSE DESCRIPTOR

Course Title	**MATERIALS, TESTING AND EVALUATION**				
Course Code	ACEB08				
Programme	B. Tech				
Semester	IV	CE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. K. Anand Goud, Assistant Professor.				
Course Faculty	Mr. K. Anand Goud, Assistant Professor. Mr. A. Jagadish Babu,Assistant Professor.				

I. COURSE OVERVIEW:

Material testing and evaluation deals with the current testing technology and examines force applications systems, force measurement, strain measurement, important instrument considerations equipment for environmental testing, and computers applications for materials testing provides an introductory treatment of basic skills in material engineering towards selecting material for the design, and evaluating the mechanical and structural properties of material, as well as the knowledge necessary for a civil engineer. The knowledge acquired lays a good foundation for analysis and design of various civil engineering structures/systems in a reliable manner. This course also deals with an experimental determination and evaluation of mechanical characteristics, advanced behavior of metallic and non-metallic structural materials and explanation of deformation and fracture behaviour of structural materials.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACEB02	III	Building Materials, Construction and Planning	4

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Materials, Testing and Evaluation	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each modules carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments/ Exams
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	Presentations on real world problems
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems anddesign system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Seminars
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Open ended experiments
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Open ended experiments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Engineering knowledge:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	3	Exams

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 2	**Broadness and diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	1	Guest Lecture
PSO 3	**Self-learning and service:** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Make measurements of behaviour of various materials used in Civil Engineering.
II	Provide physical observations to complement concepts learnt.
III	Introduce experimental procedures and common measurement instruments, equipment, devices.
IV	Disclose the variety of established material testing procedures and techniques.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Identify the different engineering materials, properties, manufacturing process of materials.	CLO 1	Identify the properties of engineering materials like cement, sand, concrete, ceramics, bitumen, structural steel etc.
		CLO 2	Explain the classification of engineering materials and uses of materials.
		CLO 3	Understand the manufacturing process of cement, concrete, bitumen, glass, plastics, metals, paints and other engineering materials.
		CLO 4	Classify the steel, glass, varnishes, adhesives, carbon composites.
CO 2	Describe the mechanical behaviour and characteristics, elastic and plastic deformation of metals, strength properties and background of fracture mechanics.	CLO 5	Explain the mechanical behaviour and characteristics of different metals.
		CLO 6	Analyze the importance of elasticity principle, characteristics and plastic deformation of metals.
		CLO 7	Explain standards for different materials, stress-strain interpretation.
		CLO 8	Describe the fundamentals of internal friction, creep, brittle fracture of steel.
		CLO 9	Understand the concept of fatigue of materials, structural integrity assessment procedure.
CO 3	Conduct mechanical testing of various metals like iron, steel and various non-ferrous metals, impact	CLO 10	Perform the mechanical testing of various metals like iron,steel and non-ferrous metals.
		CLO 11	Explain elastic deformation and plastic deformation of metals.

COs	Course Outcome	CLOs	Course Learning Outcome
	testing, background of fracture toughness of different materials, creep, fatigue.	CLO 12	Understand the impact testing, fatigue and creep of materials.
		CLO 13	Explain fracture toughness of different materials like steel and non-ferrous metals
CO 4	Understand the standard testing procedure of bricks, sand, concrete, soils, bitumen and bitumen mixes.	CLO 14	Explain the testing procedures of bricks and sand.
		CLO 15	Describe the testing procedures of fresh and hardened concrete.
		CLO 16	Understand the properties of soil by conducting the different tests.
		CLO 17	Explicate the procedures of testing bitumen and bitumen mixes.
CO 5	Describe the properties, mechanical behaviour of polymers, metals, composites, cementitious materials and special materials.	CLO 18	Understand the testing procedures of polymers and polymer based materials.
		CLO 19	Explain the behaviour of metals under various loads
		CLO 20	Describe the mechanical behaviour of composite materials.
		CLO 21	Discuss the properties of cementitious materials like fly ash, blast furnace slag.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACEB08.01	CLO 1	Identify the properties of engineering materials like cement, sand, concrete, ceramics, bitumen, structural steel etc.	PO 1	3
ACEB08.02	CLO 2	Explain the classification of engineering materials and uses of materials.	PO 1	2
ACEB08.03	CLO 3	Understand the manufacturing process of cement, concrete, bitumen, glass, plastics, metals, paints and other engineering materials.	PO 2	3
ACEB08.04	CLO 4	Classify the steel, glass, varnishes, adhesives, carbon composites.	PO 2	3
ACEB08.05	CLO 5	Explain the mechanical behaviour and characteristics of different metals.	PO 2	2
ACEB08.06	CLO 6	Understand the importance of elasticity principle, characteristics and plastic deformation of metals.	PO 4	2
ACEB08.07	CLO 7	Explain standards for different materials, stress-strain interpretation.	PO 4	3
ACEB08.08	CLO 8	Describe the fundamentals of internal friction, creep, brittle fracture of steel.	PO 5	2
ACEB08.09	CLO 9	Understand the concept of fatigue of materials, structural integrity assessment procedure.	PO 4	2
ACEB08.10	CLO 10	Perform the mechanical testing of various metals like iron,steel and non-ferrous metals.	PO 3	2
ACEB08.11	CLO 11	Explain elastic deformation and plastic deformation of metals.	PO 2	2
ACEB08.12	CLO 12	Understand the impact testing, fatigue and creep of materials.	PO 5	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACEB08.13	CLO 13	Explain fracture toughness of different materials like steel and non-ferrous metals	PO 4	3
ACEB08.14	CLO 14	Explain the testing procedures of bricks and sand.	PO 4	2
ACEB08.15	CLO 15	Describe the testing procedures of fresh and hardened concrete.	PO 4	3
ACEB08.16	CLO 16	Understand the properties of soil by conducting the different tests.	PO 4	3
ACEB08.17	CLO 17	Explicate the procedures of testing bitumen and bitumen mixes.	PO 3	2
ACEB08.18	CLO 18	Understand the testing procedures of polymers and polymer based materials.	PO 3	3
ACEB08.19	CLO 19	Explain the behaviour of metals under various loads	PO 4, PO 5	2
ACEB08.20	CLO 20	Describe the mechanical behaviour of composite materials.	PO 5	3
ACEB08.21	CLO 21	Discuss the properties of cementitious materials like fly ash, blast furnace slag.	PO 2	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)						
	PO 1	PO 2	PO 3	PO 4	PO5	PSO 1	PSO 2
CO 1	3	3		1		1	2
CO 2		2	3	2		2	1
CO 3	2	2	2	2		2	2
CO 4		2	3	3	3	1	1
CO 5	2		2	**1**		3	2

3 = High; 2 = Medium; 1 = Low

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3	3	1		1								3		
CLO 2	2												2		
CLO 3				3									3	1	
CLO 4	2			3									2		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 5				3	1									2	
CLO 6	3	2		2									3	2	
CLO 7	1	2		2									2		
CLO 8		2		3									2		
CLO 9		2	1										3		
CLO 10		2			3								1	1	
CLO 11	1		2	3									2		
CLO 12		2			3									2	
CLO 13	2	2		2									1		
CLO 14	1				3										
CLO 15													2		
CLO 16													2		
CLO 17					2								2	1	
CLO 18					2								3		
CLO 19		2											2		
CLO 20	3			3									2	3	
CLO 21	3		3	1											

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 3, PO 4, PO 5, PSO 1	SEE Exams	PO 1, PO 3, PO 4, PO 5, PSO 1	Assignments	PO 1, PO 4	Seminars	PO 3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feed Back
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Module-I	INTRODUCTION TO ENGINEERING MATERIALS
Cements, Sand, Concrete (plain, reinforced and steel fiber / glass fiber reinforced, light weight concrete, high Performance Concrete, Polymer Concrete) Ceramics, and Refractories, Bitumen and asphaltic materials, Timbers, Glass and Plastics, Structural Steel and other Metals, Paints and Varnishes, Acoustical Material and geo-textiles, rubber and asbestos, laminates and adhesives, Graphene, Carbon composites and other engineering materials including properties and uses.	
Module-II	**INTRODUCTION TO MATERIAL TESTING**
Introduction to material Engineering; Mechanical behavior and mechanical characteristics; Elasticity principle and characteristics; plastic deformation of metals; tensile test-standards for different material (brittle, quasi-brittle, elastic) True stress-strain interpretation of tensile test; hardness tests; bending andtorsion test; strength of ceramic; Internal friction, creep fundaments and characteristics; Brittle fracture of steel-temperature transition approach; Background of fracture mechanics; fracture toughness testing for different materials; concept of fatigue of materials; Structural integrity assessment procedure and fracture mechanics.	
Module-III	**STANDARD TESTING & EVALUATION PROCEDURES**
Mechanical testing of various metals; naming systems for various irons, steels and nonferrous metals; elastic deformation; plastic deformation. Impact test and transition temperatures; fracture mechanics background; fracture toughness-different materials; Fatigue of material; Creep.	
Module-IV	**STANDARD TESTING PROCEDURES**
Tests & testing of bricks, Tests & testing of sand, Tests & testing of concrete, Tests & testing of soils, Tests & testing of bitumen & bituminous mixes.	
Module-V	**TESTING PROCEDURES OF SPECIAL MATERIALS**
Testing of polymers and polymer based materials, tests and testing of metals, special materials, composites and cementitious materials. Explanation of mechanical behavior of these materials.	
Text Books:	
1. Chudley, R., Greeno, "building construction handbook", R. Butterorth Heinemann, 6th edition, 2006. 2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, "Highway Materials and Pavement Testing", Nem Chand & Bros, 5th Edition. 3. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications.	
Reference Books:	
4. KyriakosKomvopoulos, "Mechanical Testing of Engineering Materials", Cognella, 2011. 5. E.N. Dowling, "Mechanical Behaviour of Materials", Prentice Hall International, 1993. 6. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards (post 2000)	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Understand properties, different types of cement,	CLO 1	T1:3.1
3-4	Classification of sand, sources, properties of sand.	CLO 1	T1:3.9
5	Different types of concrete, properties, uses, applications.	CLO 1	T1:3.3
6	Different types of concrete, properties, uses, applications.	CLO 1	T1:3.4
7	Properties of ceramics, polymers, bitumen, asphalt.	CLO 1	T1:3.4
8-9	Explain the different types of metals, varnishes.	CLO 4	T1:3.7
10	Properties of timbers, glass, plastics and their applications.	CLO 3	T1:2.7

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
11-12	Geo-textiles, rubber, asbestos, laminates.	CLO 2	T1:2.9
13	Different types of adhesives, properties.	CLO 3	T1:2.9
14	Properties and uses of Graphene, carbon composites.	CLO 4	T1:6.2
15	Introduction to material Engineering.	CLO 5	T1:6.8
16-7	Mechanical behaviour and characteristics of materials.	CLO 5	T1:6.4
18	Elasticity principle and characteristics	CLO 6	T1:6.9
19	Plastic deformation of metals	CLO 6	T1:5.1,5.2
20-21	Tensile test-standards for different material (brittle, quasi-brittle)	CLO 7	T1:5.1,5.2
22	Tensile test-standards for different material (brittle, quasi-brittle)	CLO 7	T1:5.9
23	True stress-strain interpretation of tensile test	CLO 7	T1:5.3,5.4
24-25	Hardness tests, bending andtorsion test, strength of ceramic	CLO 6	T1:10
26	Internal friction, creep fundamentals and characteristics	CLO 8	T1:10.17
27	Brittle fracture of steel-temperature transition approach	CLO 8	T2:9.1
28-29	Background of fracture mechanics; fracture toughness testing.	CLO 9	T2:12
30	Understand the concept of fatigue of materials	CLO 9	T2:13
31	Mechanical testing of various metals	CLO 10	T2:13.1
32	Mechanical testing of various metals	CLO 10	T2:13
33	Naming systems for various irons, steels	CLO 10	T2:9.2
34	Naming systems for nonferrous metals.	CLO 10	T1:4.4
35	Understand the elastic deformation	CLO 11	T1:4.8
36	Understand the plastic deformation	CLO 11	T1:4.14, 4.
37	Explain the Impact test and transition temperatures	CLO 12	T2:11
38	Fracture mechanics background	CLO 13	T2:8
39-40	Fracture toughness-different materials	CLO 13	T2:8
41-42	Fatigue of material,Creep	CLO 12	T2:9
42-43	Explain Tests & testing of bricks	CLO 14	T2:14
44-45	Tests & testing of sand	CLO 14	T2: 7.9
46-47	Tests & testing of concrete	CLO 15	T2: 8
48-49	Explain Tests & testing of soils	CLO 16	T2: 9.3
50-51	Tests & testing of bitumen & bituminous mixes.	CLO 17	T2: 11.1
52-53	Testing of polymers and polymer based materials	CLO 18	T1: 8.7
54-55	Tests and testing of metals	CLO 19	T2:8.3
56-57	Explanation of mechanical behavior of composites	CLO 20	T2:6.9
58-59	Explanation of mechanical behavior of cementitious materials	CLO 21	T2: 10.1
60	Explanation of mechanical behavior of cementitious materials	CLO 21	T2: 10.6.

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No.	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Knowledge of construction materials, properties and uses.	Seminars/Guest Lectures	PO 3	PSO 2
2	Understand the elastic and plastic deformations of materials.	Seminars/NPTEL	PO 3	-
3	Knowledge of testing of different materials like cement, concrete, bitumen, soil etc.	Seminars/ Assignments	PO 1,PO 5	PSO 1

Prepared by:

Mr. K. Anand Goud, Assistant Professor

HOD, CE