INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATERIAL AND MECHANICS OF SOLIDS LABORATORY**				
Course Code	AMEB14				
Programme	B. Tech				
Semester	IV	M.E			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	2	1
Chief Coordinator	Mr. A. Somaiah, Assistant Professor				
Course Faculty	Dr. K. Viswanath Allamraju, Professor				

I. COURSE OVERVIEW:

Materials and mechanics of solids laboratory can examine samples to detect surface and internal flaws, determine micro structural features, evaluate heat treatments and ensure conformance to required specifications. Root cause failure analysis can also be performed when performance issues occur with metal products. One of the principle concerns of an engineer is the analysis of materials used in structural applications. The term structure refers to any design that utilizes materials that support loads and keeps deformation within acceptable limits. Designing machines, structures, and vehicles, which are reliable as well as safe and cost effective, requires a proper knowledge of engineering as well as material selection.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB04	I	Waves and Optics	4
UG	AMEB03	III	Engineering Mechanics	4

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Material and Mechanics of Solids Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Marker & talk	✘	Quiz	✘	Assignments	✘	Moocs
√	Lcd / ppt	✘	Seminars	✘	Mini project	√	Videos
√	Open ended experiments						

V. EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both are nominated by the Principal from the panel of experts recommended by Chairman, BOS.

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

20 %	To evaluate the preparedness for the programme.
20 %	To write the programme with input and computational variables.
20 %	To study the calculations and graphs related to the concern programme.
20 %	To interpret the results and the error analysis of the programme.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	Laboratory		Total Marks
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world problems
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.	2	Seminar
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design 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.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Modelling and Simulation Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Determination of mechanical properties of different materials.
II	Establish the constitutive relations in metals using destructive methods.
III	Understand the behavior of members during twisting and transverse loading.
IV	Familiarize with standard test specimens.
V	Prepare samples for investigating micro structure of different materials.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the different types of crystal structures.	CLO 1	Understand the concepts crystallography, crystal structures, unit cells, crystallographic planes, directions and miller indices.

		CLO 2	Discuss the crystal imperfections and Frank Reed source of dislocation.
		CLO 3	Demonstrate the concept of Bauschinger‟s effect, twinning, strain hardening and seasons cracking.
		CLO 4	Knowledge of yield point phenomenon, cold/hot working, recovery, re-crystallization, grain growth and strengthening of metals.
CO 2	Discuss the phase transformations and equilibrium diagram.	CLO 5	Discuss the constitution of alloys and phase diagrams, constitution of alloys, solid solutions, substitutional and interstitial.
		CLO 6	Demonstrate the phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions.
		CLO 7	Construction of iron –Iron carbide equilibrium diagram.
		CLO 8	Classification of steel and cast-Iron microstructure, properties and application.
CO 3	Ability to apply the principles of elasticity, plasticity, stresses, strains and their relationships under various types of loads and to analyze the composite bars.	CLO 9	Discuss Hooke's law, stresses and strains
		CLO 10	Derive relationship between elastic constants.
		CLO 11	Describe the concept of poisson's ratio, linear and lateral strains.
		CLO 12	Construct the Mohr's circle to solve principal stresses and strains.
CO 4	Able to draw shear force and bending moment diagrams for various loads.	CLO 13	Understand the beams and types transverse loading on beams, shear force and bend moment diagrams.
		CLO 14	Discuss types of beam supports, simply supported and over-hanging beams, cantilevers.
		CLO 15	Understand theory of bending of beams, bending stress distribution and neutral axis.
		CLO 16	Understand the shear stress distribution, point and distributed loads.
CO 5	Determination of slope and deflection of various types of beams.	CLO 17	Understand moment of inertia about an axis and polar moment of inertia.
		CLO 18	Derive the deflection of a beam using double integration Method.
		CLO 19	Computation of slopes and deflection in beams.
		CLO 20	Discuss Maxwell‟s reciprocal theorems.

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
AMEB14.01	CLO1	Understand the concepts crystallography, crystal structures, unit cells, crystallographic planes, directions and miller indices.	PO 1	3
AMEB14.02	CLO2	Discuss the crystal imperfections and Frank Reed source of dislocation.	PO 2	3
AMEB14.03	CLO3	Demonstrate the concept of Bauschinger‟s effect, twinning, strain hardening and seasons cracking.	PO 1	
AMEB14.04	CLO4	Knowledge of yield point phenomenon, cold/hot working, recovery, re-crystallization, grain growth and strengthening of metals.	PO 1	3
AMEB14.05	CLO5	Understand the concepts crystallography, crystal structures, unit cells, crystallographic planes, directions and miller indices.	PO 2	2

AMEB14.06	CLO6	Discuss the constitution of alloys and phase diagrams, constitution of alloys, solid solutions, substitutional and interstitial.	PO 2	2
AMEB14.07	CLO7	Demonstrate the phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions.	PO 1	2
AMEB14.08	CLO8	Construction of iron –Iron carbide equilibrium diagram.	PO 2	1
AMEB14.09	CLO9	Classification of steel and cast-Iron microstructure, properties and application.	PO 3	1
AMEB14.10	CLO10	Discuss Hooke's law, stresses and strains	PO 2	2
AMEB14.11	CLO11	Derive relationship between elastic constants.	PO 2	2
AMEB14.12	CLO12	Describe the concept of poisson's ratio, linear and lateral strains.	PO 1 PO 2	3
AMEB14.13	CLO13	Construct the Mohr's circle to solve principal stresses and strains.	PO 1	3
AMEB14.14	CLO14	Understand the beams and types transverse loading on beams, shear force and bend moment diagrams.	PO 1	3
AMEB14.15	CLO15	Discuss types of beam supports, simply supported and over-hanging beams, cantilevers.	PO 1	2
AMEB14.16	CLO16	Understand theory of bending of beams, bending stress distribution and neutral axis.	PO 1, PO 2	2
AMEB14.17	CLO17	Understand the shear stress distribution, point and distributed loads.	PO 1, PO 2	2
AMEB14.18	CLO18	Understand moment of inertia about an axis and polar moment of inertia.	PO 1, PO 2	3
AMEB14.19	CLO19	Derive the deflection of a beam using double integration Method.	PO 1	2
AMEB14.20	CLO20	Computation of slopes and deflection in beams.	PO 2	1

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)			
	PO 1	PO 2	PO 3	PSO1
CO 1	3	2	1	1
CO 2		2		
CO 3	3		1	
CO 4		2		1
CO 5	3	2		1

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												1		
CLO 2		2													
CLO 3	3												1		
CLO 4	3		1										1		
CLO 5		2													
CLO 6		2													
CLO 7	3														
CLO 8		2													
CLO 9			1												
CLO 10		2													
CLO 11		2											1		
CLO 12	3	2											1		
CLO 13	3														
CLO 14	3		1												
CLO 15	3														
CLO 16	3	2											1		
CLO 17	3	2											1		
CLO 18	3	2											1		
CLO 19	3												1		
CLO 20		2											1		

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3	SEE Exams	PO1, PO2, PO3	Assignments	-	Seminars	-
Laboratory Practices	PO1, PO2, PO3	Student Viva	PO1, PO2, PO3	Mini Project	-	Certification	-
Term Paper							

XIV. ASSESSMENT METHODOLOGIES–INDIRECT

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

XV. SYLLABUS

Week-I	**MICROSTRUCTURE OF PURE METALS**
Preparation and study of the micro Structure of pure metals like iron, cu and al.	
Week -2	**MICROSTRUCTURE OF STEELS**
Preparation and study of the microstructure of mild steels, low carbon steels, high–C steels.	
Week-3	**MICROSTRUCTURE OF CAST IRON**
Study of the micro structures of cast irons.	
Week-4	**MICROSTRUCTURE OF NON FERROUS ALLOYS**
Study of the micro structures of non-ferrous alloys.	
Week-5	**MICROSTRUCTURE OF HEAT TREATED STEELS**
Study of the micro structures of heat treated steels.	
Week-6	**HARDENABILITY OF STEELS**
Hardenability of steels by jominy end quench test.	
Week-7	**HARDNESS OF STEELS**
To find out the hardness of various treated and untreated steels.	
Week-8	**TENSION TEST**
To find % of elongation and young‟s modulus of a material.	
Week-9	**TORSION TEST**
To find the torsional rigidity of a material.	
Week-10	**HARDNESS TEST**
a) Brinell's hardness test. b) Rockwell hardness test.	
Week-11	**SPRING TEST**
Testing on compressive and elongation springs	
Week-12	**COMPRESSION TEST**
Compression test on springs	
Week-13	**IMPACT TEST**
a) Charpy. b) Izod test.	
Week-14	**SHEAR TEST**
Punch shear test on aluminium sheet.	
Reference Books:	
1. Sidney H Avner, "Introduction to Physical Metallurgy", McGraw Hill Education, 2nd Edition, 2008. 2. William, Callister, "Material Science and Engineering", Wiley, 9th Edition, 2014. 3. V Raghavan, "Elements of Material Science", PHI Learning Company Pvt Ltd, 6th Edition, 2015. 4. Traugott Fisher, "Material Science", 1st Edition, Academic Press Elsevier, 2013.	
Web References:	
1. https://www.labtesting.com/about/capabilities/metal-and-material-analysis/metallurgical-analysis/	

XVI. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Preparation and study of the micro Structure of pure metals like iron, cu and al.	CLO1	R1- 1.31.4 ,R2.1.7
4-6	Preparation and study of the microstructure of mild steels, low carbon steels, high–C steels.	CLO2	R2-1.8,
7-9	Study of the micro structures of cast irons.	CLO3,CLO4	R3- 1.16
10-12	Study of the micro structures of non-ferrous alloys.	CLO5,CLO6	R1- 1.6
13-15	Study of the micro structures of heat treated steels.	CLO7	R2-2.6
16-18	Hardenability of steels by jominy end quench test.	CLO2,CLO8	R3-2.10
19-21	To find out the hardness of various treated and untreated steels.	CLO3	R2-3.3
22-24	To find % of elongation and young‟s modulus of a material.	CLO3	R3-5.2
25-27	To find the torsional rigidity of a material.	CLO4,CLO11	R1- 2.16
28-30	a) Brinell's hardness test. b) Rockwell hardness test.	CLO19,CLO16	R1-2.15
31-33	Testing on compressive and elongation springs	CLO20,CLO11	R1-3.9
34-36	Compression test on springs	CLO5	R2-6.3
37-39	a) Charpy. b) Izod test.	CLO17	R2-5.3
40-42	Punch shear test on aluminium sheet.	CLO18	R-3.3

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

S No	Description	Proposed actions	Relevance with POs
1	Non Destructive Testing	Seminars/NPTEL	PO 1, PO 3
2	Flexural strength analysis	Seminars / NPTEL	PO 1, PO3

Prepared by:

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