



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	METALLURGY AND MATERIAL SCIENCE ENGINEERING				
Course Code	AME005				
Programme	B.Tech				
Semester	III	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	1	4	3	2
Chief Coordinator	Mr. M Prashanth Reddy, Assistant Professor				
Course Faculty	Mr. M Prashanth Reddy, Assistant Professor Mr. G Aravind Reddy, Assistant Professor				

I. COURSE OVERVIEW:

Metallurgy and material science subject is backbone to mechanical engineering discipline. The students are given inputs on fundamentals of crystallography, microstructures and relation to properties of materials. Also students acquire knowledge on phase diagrams, heat treatment which will enable them to select materials for industrial applications. Inputs are also planned on ceramics, glasses, polymers and composites as present day designs are based on many advanced materials.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS005	I	Engineering chemistry	3
UG	AHS008	II	Modern Physics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Metallurgy and Material Science	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 units and each unit 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 unit. 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

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). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	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	Assignments, Practical's
PO 3	Design/ development of solutions: Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Assignments, Practical's
PO 4	Conduct investigations of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignments, Practical's,
PO 12	Life-long learning: Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	1	Seminars, Practical's

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.	2	Lecture, Assignments.
PSO 2	Problem solving skills: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	1	Projects
PSO 3	Successful career and Entrepreneurship: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the physical and mechanical, metallurgical engineering concepts for metals and preparation of alloys.
II	Analyze the microstructures of metals, alloys and relationship to heat treatment.
III	Compare the properties of ceramics, glasses, composites and polymers for industrial applications.

IX. 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
AME005.01	CLO 1	Analyze the structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, Atomic packing factor, Coordinate number etc.	PO 1	3
AME005.02	CLO 2	Explain the necessity of alloying, types of solid solution and intermediate alloy phases.	PO 1	3
AME005.03	CLO 3	Explain the concept of phase and phase diagram and understand the basic	PO 1 PO 3	3 1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		terminologies associated with metallurgy.		
AME005.04	CLO 4	Construction of phase diagrams and identification of different phases and invariant reaction.	PO 1	3
AME005.05	CLO 5	Understand and suggest the heat treatment processes and types, and significance of mechanical and metallurgical properties with respect to microstructures.	PO 1	3
AME005.06	CLO 6	Explain the concept of Hardenability and demonstrate the test used to find the Hardenability of steels.	PO 1	2
AME005.07	CLO 7	Analyze the microstructure of metallic materials using phase diagram and modify the microstructure and properties using different heat treatment processes.	PO 1 PO 4	2 1
AME005.08	CLO 8	Define and differentiate engineering materials on the basis of structure and properties for engineering applications.	PO 1	2
AME005.09	CLO 9	Explain features, classification, and application of materials like polymers like thermosetting, thermoplastics.	PO 1	2
AME005.10	CLO 10	Explain features, classification, and application of materials like ceramics.	PO 1 PO 4	3 1
AME005.11	CLO 11	Explain features, classification, and application of materials like composites.	PO 1 PO 3 PO 4	3 2 2
AME005.12	CLO 12	Differentiate the properties and application of various materials like ceramics, composites and polymers.	PO 1 PO 3 PO 4	3 2 1
AME005.13	CLO 13	Enable students to understand various material standards.	PO 1	3
AME005.14	CLO 14	Enable students for selection of material for product design	PO 1 PO 3	2 2
AME005.15	CLO 15	Enable students for selection of material for manufacture.	PO 1	2
AME005.16	CLO 16	Develop skills for lifelong learning in specialized materials in engineering areas	PO 1 PO 12	2 3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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												2		
CLO 2	3												2		
CLO 3	3		1										3		

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 4	3												3		
CLO 5	3												1	1	
CLO 6	2												1		
CLO 7	2			1											
CLO 8	2												1		
CLO 9	2												2		
CLO 10	3			1										2	1
CLO 11	3		2	2									2	2	1
CLO 12	3		2	1									2	2	
CLO 13	3												2		
CLO 14	2		2										1	2	1
CLO 15	2												1	1	
CLO 16	2											3	1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	PO 1 PO 3 PO 4	Seminars	PO 12
Laboratory Practices	PO 1	Student Viva	-	Mini Project	PO 1 PO 3 PO 4	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	STRUCTURE OF METALS
Structure of metals: Crystallography, Miller indices, packing efficiency, Density calculations, Grains and grain boundaries, Effect of grain size on the properties, Determination of grain size by different methods. Constitution of alloys: Necessity of alloying, Types of solid solutions, Hume-Rothery's rules, Intermediate alloy phases	

UNIT-II	PHASE DIAGRAMS
Joint probability distributions, joint probability mass, density function, marginal probability mass, density functions; Correlation: Coefficient of correlation, the rank correlation; Regression: Regression coefficient, the lines of regression, multiple correlation and regression. Phase Diagrams: Construction and interpretation of phase diagrams, Phase rule, Lever rule. Binary phase diagrams, Isomorphous, Eutectic and Eutectoid transformations with examples.	
UNIT-III	ENGINEERING MATERIALS-I STEELS
Engineering Materials-I Steels: Iron –Carbon phase diagram and heat treatment: Study of iron-iron carbide phase diagram, Construction of TTT diagrams, Annealing, Normalizing, Hardening and Tempering of steels, Hardenability, Alloy steels.	
UNIT-IV	ENGINEERING MATERIALS –II & III
Engineering Materials –II: Cast Irons: Structure and properties of White cast iron, malleable cast iron Grey cast iron. Engineering materials –III: Non-ferrous metals and alloys: Structure and properties of aluminum copper and its alloys, Al-Cu phase diagram, Titanium and its alloys.	
UNIT-V	ENGINEERING MATERIALS –IV
Engineering materials –IV: Ceramics, Polymers and composites: Crystalline ceramics, glasses, cermets: Structure, properties and applications. Classification, properties and applications of composites, Classification, properties and applications of polymers.	
Text Books:	
1. Sidney H Avner, “Introduction to Physical Metallurgy”, McGraw-Hill Education, 2 nd Edition, 2008. 2. Donald R Askeland, Thomson, “Essentials of Material Science and Engineering”, Thomson Press, 1 st Edition, 2005	
Reference Books:	
1. Kodgire, “Material Science and Metallurgy”, Everst Publishing House, 12 th Edition, 2002 2. William, Callister, “Material science and Engineering”, Wiley, 9 th Edition, 2014. 3. V Raghavan, “Elements of Material Science”, PHI Learning Company Pvt Ltd, 6 th Edition, 2015 4. Dr. Amandeep Singh Wadhva, “Engineering Materials and Metallurgy”, Laxmi Publications, 1 st Edition, 2008.	

XIV. 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	Introduction to Metallurgy and Material Science Importance to Various Engineering disciplines	CLO1	T2-1.1
3	Branches of Metallurgy , chemical , physical , Mechanical Engineering, Metals , Non-metals, composites , nano-materials	CLO 1	T1-1.2, T2-1.2
4	Atomic structure , bonding in solids, different bonds and examples Crystal structure, unit cell, 7 crystal systems, 14 Bravais lattices, Miller indices, crystallographic planes of refrigeration	CLO 1	T1-1.4
5-7	Atomic radius , Coordination number , Atomic packing factor , Density calculation	CLO 1	T1-1.7, T2-1.8
8-11	Crystallization of pure metals ; solidification of pure metals, alloys Grains , Grain boundary , ASTM grain size no	CLO 2	T1-1.9
12	Crystal imperfections - Defects ; point , line , planar defects	CLO 2	T2-1.9
13	Phase diagrams : Phase rule	CLO 3	T1-3.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
14	Binary alloys – phase diagrams: Isomorphous system. Cu-Ni	CLO 3	T1-3.3
15-16	Chemical composition of phases , Lever rule , Equilibrium cooling , Non - Equilibrium cooling	CLO 3	T1-3.4, T2-4.4
17-18	Eutectic system. I Bi-Cd , Hypo, Hyper II Pb-Sn system	CLO 4	T2-4.5
19-20	Peritectic system Pt-Ag, Eutectoid reaction, Peritectoid reaction	CLO 3	T1-3.6, T2-4.5
21-22	Engineering Materials – 1 steels	CLO 4	T1-5.1
23-24	Steel :Fe – C ; Allotropy of Fe	CLO 4	T1-5.2
25	Peritectic transformation	CLO 4	T1-5.3,
26	Eutectoid transformation	CLO 5	T1-5.4
27	Hyper eutectoid transformation	CLO 5	T1-5.5
28	Heat treatment , Annealing Normalizing , Hardening , Tempering	CLO 5	T2-5.7
29-30	Hardenability	CLO 6	T1-6.1,
31	Alloy steels – Effect of alloying elements	CLO 6	T1-6.2,
32	Low alloy steels , stainless steels , Tool steels	CLO 6	T2-6.5,
33-35	Engineering Materials – II & III	CLO 6	T1-7.1,
36-37	White Cast Iron , Malleable CI , Grey CI , SG Iron	CLO 7	T2-6.7,
38-41	Engineering materials III :Nonferrous alloys – classification	CLO 7	T1-8.1,
41-42	Copper alloys	CLO 8	T2-7.2,
43-45	Al-alloys	CLO 8	T1-8.5,
46-48	Titanium alloys	CLO 8	T2-7.9,
49-50	Ceramics , Types , properties , applications	CLO 10	T2-10.1
51-53	Glasses , Types , Properties , applications	CLO 10	T2-10.3
54-56	Cermets , Types , Properties , applications	CLO 12	T2-10.5
57-58	Composites , Types , Properties , applications	CLO 11	T2-10.6
59-60	Polymers , Types , Properties , applications	CLO 09	T2-10.9

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Crystal imperfections	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3	PSO 1
2	Solidification and crystallization, Recovery, recrystallization and grain growth.	Seminars / Guest Lectures / NPTEL	PO 2, PO 5	PSO 2
3	Material characterization	Assignments / Laboratory Practices	PO 1, PO 3, PO 4	PSO 2

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