INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**:**	**METALLURGY AND MATERIAL SCIENCE**			
Course Code	**:**	**A31803**			
Course Structure	**:**	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	:	4	1	-	4
Course Coordinator	**:**	Dr. K.G.K.MURTI, Professor.			
Team of Instructors	**:**	Dr. N N Ramesh, 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. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Physics, Chemistry,Mathematics, Drawing

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

I. **Understanding** of metallurgical engineering concepts and properties.
II. **Analyze** of microstructures of metals and alloys and relationship to heat treatment.
III. **Compare** the properties of ceramics, glasses, composites and polymers for industrial applications.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. **Relate** properties of metals to micro structures.
2. **Apply** the principles of heat treatment for improving properties.
3. **Select** metals and alloys for engineering applications.
4. **Understand** various advantages and limitations of non-metals.
5. **Identify** suitable metals, non-metals for various industrial products

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examination
PO2	An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	H	Assignments, Practicals, Midterm and University examination
PO3	Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments, Practicals, Midterm and University examination
PO4	To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	H	Assignments, Practicals, Midterm and University examination
PO5	An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	H	Assignments, Practicals,

			Midterm and University examination
PO6	To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	Practicals, Projects
PO7	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	S	Practicals, Projects
PO8	An understanding and implementation of professional and ethical responsibilities.	S	Practicals, Projects
PO9	To function as an effective individual and as a member or leader in multi disciplinary environment and adopt in diverse teams.	S	Practicals, Midterm and University examination, Projects, Technical activites.
PO10	An ability to assimilate, comprehend, communicate, give & receive instructions to present effectively with engineering community and society.	S	Practicals, Midterm and University examination, Projects, Technical activites.
PO11	An ability to provide leadership in managing complex engineering projects at multidisciplinary environment and to become a Technocrat.	H	Practicals, Midterm and University examination, Projects, Technical activites. Mini Projects
PO12	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	H	Practicals, Midterm and University examination, Projects, Technical activites.

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills:** Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examination
PSO 2	**Engineering practices:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	S	Assignments , Practicals, Midterm and University examination

PSO 3	**Successful Career:** Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments Practicals, Midterm and University examination

N - None **S - Supportive** **H – Highly Related**

IX. SYLLABUS

UNIT-I

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 rules, Intermediate alloy phases

UNIT-II

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: 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, Hardenabilty, Alloy steels.

UNIT-IV

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 copper and its alloys, Al-Cu phase diagram, Titanium and its alloys.

UNIT-V

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.

Textbooks:

1. Material science and Metallurgy /Kodgire
2. Essentials of Material science and engineering/Donald R Askeland/Thomson

Referencebooks:

1. Introduction to Physical Metallurgy/Sidney H Avner.
2. Material science and Engineering/William and Callister
3. Elements of Material science/V Raghavan
4. Engineering Materials and Metallurgy/Er.Amandeep Singh Wadhva
   Material science for engineering students-Traugott Fisher 2009 Edition.

X. COURSE PLAN:

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

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1-2	**Identify** potential areas of applications in mechanical engineering	**Introduction to Metallurgy and Material Science** **Importance to Various Engineering disciplines**	T2
3	**Define** various branches and compare metals and non-metals	Branches of Metallurgy , chemical , physical , Mechanical Engineering , Metals , Non-metals, composites , nano-materials	T1,T2
4	**Compare** various crystal structures	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	T1
5-7	**Examine** various factors of crystal structures	Atomic radius , Coordination number , Atomic packing factor , Density calculation	T1,T2
8-12	**Compare** pure metals and alloys	Crystallization of pure metals ; solidification of pure metals , alloys Grains , Grain boundary , ASTM grain size no	T1
13	**Describe** defects in crystals	Crystal imperfections - Defects ; point , line , planar defects	T2
14	**Describe** Phase diagrams	**Phase diagrams : Phase rule**	T1,T2
15	**Explain** Cu-Ni Phase diagram	Binary alloys – phase diagrams: Isomorphous system. Cu-Ni	T1
16-17	**Analyze** types of cooling	Chemical composition of phases , Lever rule , Equilibrium cooling , Non - Equilibrium cooling	T1,T2
18-19	**Describe** Bi-Cd and Pb-Sn system	Eutectic system . I Bi-Cd , Hypo , Hyper II Pb-Sn system	T2
20-21	**Describe** the Pt-Ag system ,and explain various eutectoid and peritectoid reactions	Peritictic system Pt-Ag, Euctectoid reaction Peritectoid reaction	T1,T2
22-23	**Categorize & Describe** steels	**Engineering Materials – 1 steels :**	T1
24-26	**Explain** Fe-C diagram	Steels :Fe – C ; Allotropy of Fe	T1
27	**State** peritectic reaction	Peritictic transformation	T1,T2
28	**Explain** eutectoid reaction	Eutectoid transformation	T1

29	**Describe** Hyper eutectoid transformation	Hyper eutectoid transformation	T1
30	**Discuss** heat treatment	Heat treatment , Annealing Normalizing , Hardening , Tempering	T2
31-32	**Evaluate** hardenabilty	Hardenability	T1,T2
33	**Describe** the effect of alloying elements	Alloy steels – Effect of alloying elements	T1,T2
34	**Explain** types of alloy steels	Low alloy steels , stainless steels , Tool steels	T2,T1
35-38	**Explain** Types of cast irons	**Engineering Materials – II&III**	T1,T2
39-40	**Describe** various cast irons	White Cast Iron , Malleable CI , Grey CI , SG Iron	T2,T1
41-49	**Examine** classification of aluminium alloys	Engg. materials III :Non ferrous alloys – classification	T1,T2
50-51	**Discuss** the properties of copper alloys	Copper alloys	T2,T1
52-56	**Describe** Al alloys	Al-alloys	T1,T2
57-58	**Describe** the properties of titanium alloys	Titanium alloys	T2,T1
68	Explain **ceramics**	Engineering materials –IV:**Ceramics , Types , properties , applications**	T2
69-70	Describe **glasses**	Glasses , Types , Properties , applications	T2
71-72	Explain **cermets**	Cermets , Types , Properties , applications	T2
73-74	Describe **composites**	Composites , Types , Properties , applications	T2
75-76	Explain **polymers**	Polymers , Types , Properties , applications	T2

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	S						H			H				H	H
II			S				H			H			S	H	H
III							H			H				H	H

N = None **S = Supportive** **H = Highly related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF TSHE PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		S						H						S	H
2				S							H		S	H	S
3				S				H						H	H
4				S									S	S	S
5	H			H										H	S

N = None **S = Supportive** **H = Highly related**

Prepared by:
Dr. K. G. K. Murti, Professor.
Dr. N. N. Ramesh, Professor.

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