19ME202 MATERIALS SCIENCE AND METALLURGY

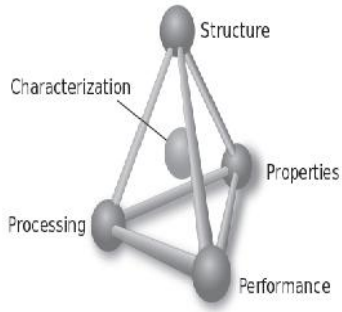
Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
30	30	-	-	5	5



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COURSE DESCRIPTION AND OBJECTIVES:

This course offers fundamentals of crystallography, metallurgy, heat treatment, powder metallurgy, strengthening mechanisms, ceramics and composites. The objective of this course is to impart basic knowledge on various classes of materials, structures and its properties.

COURSE OUTCOMES:

Upon completion of the course the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Compute the crystal geometry in terms of crystal planes and defects.	1
2	Apply the concepts of solid solutions, cooling curves and phase diagrams and understand the covncepts of Iron- Iron carbide equilibrium diagram and TTT diagrams.	2
3	Compare and contrast the need of different heat treatment for processing of metals and alloys.	2
4	Identify the appropriate methods to fabricate materials and composites.	5
5	Identify a suitable material for various applications and manufacturing process.	2

SKILLS:

- ✓ *Specify carbon compositions in cast iron and steels.*
- ✓ *Identify the effects of alloying elements on properties of cast iron and steels.*
- ✓ *Recognize series of heat treatment processes to achieve desired properties for a specific application.*
- ✓ *Classify ceramic materials on the basis of bonding and structures.*

UNIT- I **L-9**

INTRODUCTION TO SOLIDS: Bonding in Solids (Types), Crystalline and amorphous solids, Lattice points and Space lattice, Basis, Crystal structure, Unit cell, Primitive cell and Lattice parameters, Crystal systems and Bravais lattices, Packing factor - SC, BCC and FCC; Miller indices, Imperfections in materials.

UNIT- II **L-9**

SOLID SOLUTIONS: Types of solids solutions, Solid solution strengthening Rules for governing the formation of solid solutions and intermediate phases; Cooling curves and phase diagrams **-** Construction of phase diagrams, Gibbs phase rule and Lever rule.

FERROUS MATERIALS: Fe-Fe_3C phase diagram, Composition, properties and applications of low, medium and high carbon steels, alloy steels, stainless steels and designation of steels; Cast irons - types, composition, properties and applications of Grey, Malleable, Nodular and White cast irons.

UNIT- III **L-9**

HEAT TREATMENT PROCESSES: Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Austempering, Surface heat treatment methods and heat treatment of Non-ferrous materials - Dispersion hardening, Precipitation hardening. TTT diagram - construction of TTT diagram, TTT diagram for eutectoid steels, Continuous cooling curves.

UNIT- IV **L-9**

POWDER METALLURGY: Introduction to powder metallurgy, Advantages of powder metallurgy, Manufacturing processes, Production of metal powders, Compacting, Sintering, Products of powder metallurgy.

NON-FERROUS MATERIALS: Aluminium and its alloys, Copper and its alloys, Titanium and its alloys.

UNIT- V **L-9**

COMPOSITE MATERIALS: Introduction, Types of composites based on matrix and reinforcement, Influence of fiber length, concentration and orientation; Manufacturing methods for composites, MMCs - Liquid-metal infiltration, Stir casting; PMCs - Hand layup, Extrusion, Injection moulding, Compression moulding.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS **TOTAL HOURS: 30**

1. To study crystal structures of a given specimen.
2. To study crystal imperfections in a given specimen.
3. To prepare solidification curve for a given specimen.
4. To study heat treatment processes (hardening and tempering) of steel specimen.
5. To study microstructures of metals / alloys.
6. Fabricate metal matrix composites using powder metallurgy route.
7. Fabricate non ferrous materials using powder metallurgy route.
8. Fabricate polymer matrix composites using hand layup technique.
9. To study microstructure of heat-treated steel.
10. To study crystal structures and crystals imperfections using ball models.

TEXT BOOKS:

1. Smith, “Foundations of Materials Science and Engineering”, 4th edition, McGraw-Hill, 2009.
2. William D. Callister, “Material science and Engineering and Introduction”, Wiley, 2006.

REFERENCE BOOKS:

1. V. Raghavan, “Materials Science and Engineering”, PHI, 2002,
2. Donald R. Askland and Pradeep.P. Phule, “The Science and Engineering of Materials”, 4th edition, Cengage Learning, 2003.
3. Ed. George F. Vander Voort, ASM Handbook Vol. 9: “Metallography and Microstructure”, ASM International, 2004.