

# 16ME202 MATERIAL SCIENCE AND METALLURGY



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	30	60	-	10	-	10

## Course Description and Objective:

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:

The student will be able to:

- understand the various aspects of materials and metallurgical engineering.
- explain iron-iron carbide phase diagram with isomorphous reactions.
- apply any heat treatment process for any specific application and requirement.
- describe powder production methods for different metals.
- identify suitable strengthening mechanisms for metals and alloys.
- understand various structures of ceramic materials and their governing rules .
- recognize composites and its types based on their matrix and reinforcing agents.

## 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.*

*Use various powder production and compacting techniques for intricate parts.*

*Classify ceramic materials on the basis of bonding and structures.*

*Differentiate composites based on its constituent materials.*

**UNIT - 1****L-9****IRON-IRON CARBIDE DIAGRAM:** Constitution, Microstructures and Properties.**CAST IRON AND STEELS:** Constitution and Properties of Grey, White, Malleable and Spheroidal Graphite cast irons, Effect of Silicon, Manganese, Sulphur, Phosphorous and other elements on the properties of Cast Iron, Effect of alloying elements such as Manganese, Nickel, Chromium, Molybdenum, Vanadium, Tungsten, Cobalt and Boron on steels, Plain Carbon Steels, Stainless Steels.**UNIT - 2****L-9****HEAT TREATMENT OF STEEL:** Annealing, Normalizing, Hardening, Carburizing, Nitriding, Cyaniding, Induction hardening, Flame hardening, Age hardening, Hardenability, Controlled atmosphere in heat treatments, TTT and CCT diagrams.**UNIT - 3****L-9****STRENGTHENING MECHANISMS:** Strengthening by grain-size reduction, Solid solution strengthening, Strain hardening, Dispersion hardening, Recovery, Recrystallization and Grain growth. **POWDER METALLURGY:** Introduction to powder metallurgy, Advantages of powder metallurgy, Production of metal powders, Compacting, Sintering, Products of powder metallurgy.**UNIT - 4****L-9****CERAMICS:** Ceramics as a class of material, Classification of ceramics, Bonding and Structure of various ceramic materials - AX,  $A_mX_p$ ,  $A_mB_nX_p$ ; Rules - Pauling, Zachariasen, Stanworth; Structure of silicates, Defects in ceramics.**UNIT - 5****L-9****COMPOSITES:** Introduction, Types of composites based on Matrix and Reinforcement, Influence of fiber length, Concentration and Orientation of fibers, Manufacturing methods of MMC's - Liquid-metal infiltration, Stir casting; Manufacturing methods of PMC's - Hand layup, Extrusion, Injection moulding, Compression moulding.**ACTIVITIES:**

- *Sample preparation for morphological analysis.*
- *Manufacturing of a few intricate parts using metal powders and testing their properties.*
- *Strengthening of materials using severe plastic deformation and testing their properties.*
- *Fabrication of fiber reinforced polymer composites and testing their properties.*

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours:30

1. Microstructure of Mild steels, Low carbon steels, High carbon steels.
2. Microstructures of cast Irons.
3. Microstructures of heat treated steels.
4. Hardenability of steels by Jominy end quench test.
5. Hardness of various treated and untreated steels.
6. Fiber reinforced composites
7. Microstructure and hardness of plastically deformed materials

**TEXT BOOKS:**

1. Avner, "Introduction to Physical Metallurgy", 2<sup>nd</sup> edition, McGraw Hill International Book Company, 1997.
2. William D. Callister, "Materials Science and Engineering an Introduction", 2<sup>nd</sup> edition, John Wiley and Sons, 2014.

**REFERENCE BOOKS :**

1. Kodgire UD, "Material Science and Metallurgy", 37<sup>th</sup> edition, Everest Publishing House, 2015.
2. Raghavan V, "Materials Science and Engineering ", 6<sup>th</sup> edition, Prentice Hall of India Pvt.Ltd., 2015.

**WEB LINKS:**

1. <http://nptel.ac.in/course.php?disciplineld=113>
2. <http://www.learnerstv.com/Free-engineering-Video-lectures-ltv180-Page1.htm>
3. <http://freevideolectures.com/Course/2266/Material-Science#>
4. <http://ocw.mit.edu/courses/materials-science-and-engineering/3-012-fundamentals-of-materials-science-fall-2005/lecture-notes/>