MATERIAL SCIENCE AND ENGINEERING
(Common to all branches)

Course Code: 19ME1103

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Course Outcomes:

At the end of the Course the student shall be able to

CO1: explain binary phase diagrams.

CO2: apply heat treatment to different applications.

CO3:.select steels and cast irons for a given application.

CO4:.select nonferrous metals and alloys in engineering.

CO5: choose composites for various applications and assess the properties of nano-scale materials and their applications.

UNIT-I **07 Lectures**

Structure of Metals: metallic crystal structures: BCC, FCC and HCP, crystallization, crystal imperfections: point, line, interstitial and volume defects; plastic deformation: slip and twinning

Constitution of Alloys: substitutional and interstitial solid solutions- binary phase diagrams:

isomorphous system, eutectic, peritectic, eutectoid and peritectoid reactions

Learning outcomes:

At the end of this unit the student will be able to

1. formulate the density of metal from lattice parameters (L6)
2. differentiate various kinds of crystal imperfections (L4)
3. interpret phase diagrams (L3)

UNIT-II **07 Lectures**

Iron-Iron Carbide Diagram: Iron-Iron Carbide diagram and microstructural aspects of ferrite, cementite, pearlite, austenite and ledeburite, Plain carbon steels and their applications

Heat Treatment of Steels: annealing, normalizing, hardening and tempering; TTT diagrams, austempering, martempering, case hardening methods

Learning outcomes:

1. interpret Fe-Fe_3C phase diagram (L2)
2. describe the composition, microstructure, properties and applications of plain carbon steels (L2)
3. select appropriate heat treatment process to improve desired properties of steels (L5)

UNIT-III **06 Lectures**

Alloy Steels: Effect of alloying elements on Iron-Iron carbide diagram, Hadfield manganese steel, stainless steels, tool steels, HSS.

Cast irons: Micro structure, properties and applications of white cast iron, malleable cast iron, grey cast iron, nodular cast iron and alloy cast irons.

Learning outcomes:

At the end of this unit the student will be able to

1. classify various types of alloy steels along with their properties and applications. (L4)
2. outline various types of cast irons along with their properties and applications. (L4)
3. compare the relative merits of steels and cast irons (L5)

UNIT-IV **06 Lectures**

Non-ferrous Metals and Alloys: Composition, microstructure, properties and applications of copper base, aluminum base and titanium base alloys

Polymeric Materials: Structure and properties of polymeric materials and their applications

Learning outcomes:

At the end of this unit the student will be able to

1. describe the composition, microstructure, properties and applications of copper based, aluminum based and titanium based alloys (L2)
2. differentiate between thermoplastics and thermosets (L4)
3. describe the applications of plastics (L2)

UNIT-V **06 Lectures**

Ceramic Materials: Ceramics, abrasive materials, Nano- materials-definition, properties and applications for the above.

Composite Materials: Particle reinforced materials, fiber reinforced materials, metal ceramic and polymeric matrix composites and C-C composites.

Learning outcomes:

At the end of this unit the student will be able to

1. explain ceramic, abrasive and nano materials (L2)
2. differentiate various types of composite materials (L4)
3. describe the applications of ceramic, abrasive, nano and composite materials (L2)

Text Books:

1. S.H.Avner, *Introduction to Physical Metallurgy*, 2nd Edition, Tata McGraw- Hill, 2017. (Units I-IV)

2. Kalpakjian S and Schmid S, *Manufacturing Engineering and Technology (SI Edition)*,. Pearson Publishers, 2018 (Unit V)

Reference Books:

1. Kodgire VD and Kodgire SV, *Material Science and Metallurgy for Engineers*, Everest Publishing House, 2018
2. Y. Lakhtin, *Engineering Physical Metallurgy*, University Press of the Pacific, 2005.
3. L.H.Van Vlack, *Elements of Material Science and Engineering*, 6th Edition/e, Pearson Education, 2008.