MATERIALS SCIENCE

Course Code: 13ME1106

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Course Educational Objectives:

To make the student

- To acquire fundamental knowledge about metals and materials used in engineering
- To understand crystal systems, constitution of alloys and phase diagrams.
- To select ferrous and non ferrous alloys and recognize their relative merits and demerits
- To acquire knowledge about ceramic, composite and nano materials.
- To understand basics of powder metallurgy technique

Course Outcomes:

The student will be able to

- Explain the constitution of alloys
- Apply phase diagrams for the study of alloys.
- Select various ferrous and non ferrous materials for engineering applications
- Select ceramic and composite materials for engineering applications

UNIT-I (12 Lectures)

STRUCTURE OF METALS:

Bonds in solids-metallic bond-crystal structure-BCC, FCC, HCP, unit cells, packing factor, crystallization of metals, grains and grain boundaries, effect of grain boundaries on properties of metals, crystal imperfections, determination of grain size.

MECHANICAL BEHAVIOR OF MATERIALS:

Elastic deformation, plastic deformation- twinning, fracture, fatigue, creep.

UNIT-II (12 Lectures)

CONSTITUTION OF ALLOYS:

Necessity of alloying, types of solid solutions, Hume Rothery rules, intermediate alloy phases and electron compounds.

Equilibrium diagrams: Phase rule, experimental method of construction of equilibrium diagrams, isomorphous alloy systems, equilibrium cooling and heating of alloys. lever rule, coring, miscibility gaps, eutectic systems. congruent melting intermediate phases, peritectic reaction, transformations in solid state – allotropy, eutectoid, peritectoid reactions, relationship between equilibrium diagrams and properties of alloys. study of important binary phase diagrams: Cu-Ni, Al-Cu, Bi-Cd.

UNIT-III (12 Lectures)

Metallurgy of iron and steel: Fe-Fe_3C equilibrium diagram, micro constituents in steels, classification of steels, structure and properties of plain carbon steels.

Heat treatment of steels- annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface hardening methods, age hardening treatment

Effect of alloying elements on Fe-Fe_3C system, low alloy steels, stainless steels, Hadfield manganese steels, tool steels and die steels, structure and properties of white cast iron, malleable cast iron, grey cast iron and spheroidal grey cast iron.

UNIT-IV (12 Lectures)

Non-ferrous metals and alloys: Structure and properties of copper and its alloys, aluminum and its alloys and titanium and its alloys.

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

UNIT-V (12 Lectures)

CERAMIC MATERIALS:

Crystalline ceramics, glasses, cermets, abrasive materials, Nano materials-definition, properties and applications of the above.

COMPOSITE MATERIALS:

Classification of composites, particle reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal-matrix composite and C-C composites. Introduction to powder metallurgy.

TEXT BOOKS:

1. Sidney H Avner, *"Introduction to Physical Metallurgy"*, Tata McGraw Hill, 2nd Edition, 2011.
2. Kodgire, *"Materials Science and Metallurgy"*, Everest Publishing House, 3rd Edition, 2012
3. Kalpakjian S, Schmid S, *"Manufacturing Engineering and Technology"*, Pearson Edu., 2009.

REFERENCES:

1. Van Vlack, *"Elements of materials science and Engineering"*, Dorling Kindersley (India) Pvt. Ltd., 2009.
2. V.Raghavan, *"Elements of materials science"*, Pearson Education, 2005.
3. Callistar, "Metallurgy and Materials Science", Wiley India, 2010.