GOKARAJU RANGARAJU
INSTITUTE OF ENGINEERING AND TECHNOLOGY

MATERIAL SCIENCE AND METALLURGY

Course Code: GR15A2022 L:3 T:1 P:0 C:4
II Year I Semester

Prerequisites: Basic knowledge from Engineering, Physics and Chemistry.

Course Objectives
- Know the fundamental science and engineering principles relevant to materials.
- Understand the relationship between nano and microstructures, characterization, properties processing and design of materials.
- Have the experimental and computational skills for a professional career in study of materials.
- Possess knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.

Course Outcomes
- Ability to relate properties of microstructures.
- Ability to relate various crystal structures and relationship between the different materials
- Ability to select metals and alloys for industrial applications
- Familiarity with non-metals and their applications
- Understanding heat treatment procedures and corresponding change of properties
- To manufacture different products with composite structures in place of metals

Unit-I
Structure of Metals: Bonds in Solids – Metallic bond , crystallization of metals, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys – determination of grain size. Crystal systems indices for planes and directions, crystal defects and dislocations, Mechanism of plastic deformation.

Constitution of Alloys: Necessity of alloying, types of solid solutions, Hume Rothery's rule, intermediate alloy phases, and electron compounds.

Unit-II
Equilibrium of Diagrams: Experimental methods 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 the solid state –allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of important binary phase diagrams of Cu-Ni-, Al-Cu, Bi-Cd, Cu-An, Cu-Sn and Fe-Fe_3C.

Unit-III

Cast Irons and Steels: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheriodal graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Unit-IV

Heat treatment of Alloys: Effect of alloying elements on Fe-Fe_3C system, Annealing, normalizing, Hardening, TTT diagrams, tempering , Harden ability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys.

Unit-V

Ceramic materials: Crystalline ceramics, glasses, cermets, abrasive materials, nano materials –definition, properties and applications of the above.

Composite materials: Classification of composites, various methods of manufacture of composites, particle–reinforced materials, fibre-reinforced materials, metalceramicmixtures, metal–matrix composites and Carbon–Carbon composites.

Teaching Methodology

Power point Presentations, Working models, white board & marker

Text Books

1. Introduction to Physical Metallurgy / Sidney H. Avener/TMH
2. Materials Science and engineering / William and Callister/WILEY

Reference Books

1. Material Science and Metallurgy/kodgire.
2. Science of Engineering Materials / Agarwal
3. Essential of Materials science and engineering/ Donald R.Askeland/Thomson.
4. Elements of Material science / V. Raghavan
5. Engineering Materials and Their Applications – R. A Flinn and P K Trojan / Jaico Books.
6. Engineering materials and metallurgy/R.K.Rajput/ S.Chand.