

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

**DEPARTMENT OF MECHANICAL ENGINEERING**

<b>II Year - II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MATERIALS SCIENCE &amp; METALLURGY</b>					

**Course Objective:** To understand the basic fundamentals of Material science and Physical metallurgy. The basic concepts to be taught will help for the improvement, proper selection and effective utilization of materials which is essential to satisfy the ever increasing demands of the society.

**UNIT – I**

**Structure of Metals and Constitution of alloys:** Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor - SC, BCC, FCC & HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries on the Properties of metal / alloys – determination of grain size. Imperfections

– point, line, surface and volume- Slip and Twinning.

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

**Equilibrium 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 binary phase diagrams such as Cu-Ni and Fe-Fe<sub>3</sub>C.

**UNIT –II**

**Ferrous metals and alloys:** Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal 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.

**Non-ferrous Metals and Alloys:** Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

**UNIT – III**

**Heat treatment of Alloys:** Effect of alloying elements on Fe-Fe<sub>3</sub>C system, Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

**UNIT – IV**

**Powder Metallurgy:** Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Sintering Secondary operations-Sizing, coining, machining -Factors determining the use of powder metallurgy-Application of this process.

**UNIT – V**

**Ceramic and composite materials:** Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, various methods of component manufacture of composites, particle – reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal – matrix composites and C – C composites. Nano-materials – definition, properties and application

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**TEXT BOOKS:**

1. Introduction to Physical Metallurgy - Sidney H. Avener -McGrawHill
2. Essential of Materials science and engineering - Donald R.Askeland -Cengage.

**REFERENCES:**

1. Material Science and Metallurgy – Dr. V.D.kodgire- Everest PublishingHouse
2. Materials Science and engineering - Callister&Baalasubrahmanyam- Wiley Publications
3. Material Science for Engineering students – Fischer – ElsevierPublishers
4. Material science and Engineering - V. Rahghavan-PHIPublishers
5. Introduction to Material Science and Engineering – Yip-Wah Chung CRCPress
6. Material Science and Metallurgy – A V K Suryanarayana – B SPublications
7. Material Science and Metallurgy – U. C. Jindal – PearsonPublications

**Course Outcomes:**

- CO1: Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
- CO2: Study the behavior of ferrous and non ferrous metals and alloys and their application in different domains
- CO3: Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
- CO4: Grasp the methods of making of metal powders and applications of powder metallurgy
- CO5: Comprehend the properties and applications of ceramic, composites and other advanced methods.