MATERIAL SCIENCE AND METALLURGY

Course Code	20ES1303	**Year**	II	**Semester**	I
Course Category	Engineering Science	**Branch**	ME	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	Chemistry of Materials
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

Course Outcomes		**Unit**	**Level**
Upon successful completion of the course, the student will be able to			
CO1	Understand crystallography, constitution of alloys, Heat treatment Processes and properties of ferrous and non-ferrous metals.	1,2,3,4,5	L2
CO2	construct the phase diagrams of materials and illustrate the concept of Strengthening Mechanisms	2	L3
CO3	interpret heat treatment and surface hardening techniques	3	L3
CO4	Appraise properties of different stainless steels, tool steels, cast irons and non-ferrous materials	4	L4
CO5	Establish features of ferrous, non-ferrous alloys and composite materials	5	L4

	Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	1		2					2			3	2
CO2	2	3	1		2					2			3	2
CO3	2	2	2	1	2					2			3	2
CO4	2	2	2	1	2		1			2			3	2
CO5	2	2	2	1	2		1			2			3	2

Syllabus		
Unit No.	**Contents**	**Mapped CO**
1	**Materials Science and Engineering**: Introduction, Classification of Materials, Mechanical Properties of Materials, Case Study: Delhi Iron Pillar and Wootz Steel. **CRYSTALLOGRAPHY:** Unit cell, Classification, Bravais Lattices, packing factor and coordination number in cubic systems, Miller Indices for Cubic systems, imperfections in solids: Point, Line and Volume, Slip and Twinning. Determination of grain size.	**CO1**
2	**Mechanism of Crystallization:** Nuclei Formation, crystal growth **CONSTITUTION OF ALLOYS:** Types of solid solution- substitutional and interstitial solid solutions, Hume Rothery rules for solid solution. **PHASE DIAGRAMS:** Phase, Phase equilibrium, Gibbs Phase rule – one component system, two component system, Construction of binary phase diagram, Isomorphous, eutectic, eutectoid, peritectic and peritectoid systems, Fe-Fe_3C equilibrium diagram, Lever rule: Isomorphous. **STRENGTHENING MECHANISMS:** Grain Refinement, Strain hardening, solid solution strengthening, Dispersion strengthening.	**CO1,2**

3	**HEAT TREATMENT PROCESSES:** stages of heat treatment, TTT and CCT diagram of eutectoid steel, Annealing: Full Annealing, Spherodizing, Stress Relief Annealing, Process Annealing, Normalizing, Hardening, Tempering, Austempering, Martempering. **CASE HARDENING:** Flame hardening, Induction hardening, Carburizing, Cyaniding, Nitriding.	**CO1,3**
4	**STEELS: STAINLESS STEELS**: Ferritic, Martensitic, Austenitic, **Tool steels:** Water Hardened, Shock Resistance, Cold-Work, Hot-Work Tool Steels, Applications and Properties. **CAST IRONS:** Structure, Properties and Applications of White Cast iron, Malleable Cast iron, Grey cast iron, Spheroidal graphite cast iron.	**CO1,4**
5	**NON-FERROUS METALS AND ALLOYS:** Properties and Applications of Copper and its alloys: Cartridge Brass, Cupronickel, Gun Metal, Naval Brass, Bell Metal, Phosphor Bronze. **ALUMINIUM AND ITS ALLOYS:** Properties and Applications of Duralumin, Hindalium, Magnalium, Aluminium–Scandium, **TITANIUM AND ITS ALLOYS:** Properties and Applications of α and Near α, β Alloys, α-β Alloys. **COMPOSITE MATERIALS:** Classification of composites, particle reinforced materials, fiber reinforced composite materials and metal matrix composites.	**CO1,5**

Learning Resources

Text Book(s):

1. R.Balasubramaniam, Callister's, Material Science and Engineering, 2/e, WileyIndia,2014.
2. S.H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGrawHill, 1997.

Reference Books:

1. Donald R. Askeland, "Essential of Materials Science and Engineering", Thomson Learning, 5 th Edition – 2006
2. V.D. Kodgire, "Material Science and Metallurgy", Everest Publishing House - 25th Edition – 2009.
3. B.K.Agarwal, "Introduction to Engineering Materials", Tata McGraw Hill-1stEdition.
4. V. Raghavan, "Material Science and Engineering",-PHI Learning - 5th Edition.

E Resources & other Digital Material:

http://materials.iisc.ernet.in/~wootz/heritage/WOOTZ.htm
http://met.iisc.ernet.in/~rangu/text.pdf
https://nptel.ac.in/courses/113106032/
https://nptel.ac.in/courses/113107078/
http://vvm.org.in/study_material/ENG%20-%20Indian%20Contributions%20to%20Science.pdf