MATERIAL SCIENCE AND METALLURGY

Course Code	20ES1303	Year	II	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Chemistry of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand crystallography, constitution of alloys, Heat treatment Processes and properties of ferrous and non-ferrous metals.	Understand	L2	1,2,3,4,5
CO2	construct the phase diagrams of materials and illustrate the concept of Strengthening Mechanisms	Apply	L3	2
CO3	interpret heat treatment and surface hardening techniques	Apply	L3	3
CO4	Appraise properties of different stainless steels, tool steels, cast irons and non-ferrous materials	Analyze	L4	4
CO5	Establish features of ferrous, non-ferrous alloys and composite materials	Analyze	L4	5

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	Contents	Mapped CO
I	**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
II	**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 CO2

III	**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** **CO3**
IV	**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** **CO4**
V	**Radiation Heat Transfer:** Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann. Heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.	**CO1** **CO5**

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

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