MATERIAL SCIENCE AND METALLURGY

Course Code	**23ME3302**	**Year**	II	**Semester**	I
Course Category	Professional Core	**Branch**	ME	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	Engineering Physics
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

COs	**Statements**	**Skill**	**Blooms Level**	**UNITS**
CO1	Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.	Understand	L2	1
CO2	Study the behavior of ferrous and non-ferrous metals and alloys and their application in different domains.	Understand	L1	2
CO3	Understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.	Understand	L2	3
CO4	Grasp the methods of making of metal powders and applications of powder metallurgy.	Apply	L3	4
CO5	Comprehend the properties and applications of ceramic, composites and other advanced methods.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Medium, 1: Low)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO-1	PSO-2
CO-1	1		1		3					3			3	1
CO-2	1		1		3					3			3	1
CO-3	1	2	3	3	3	2	3			3			3	1
CO-4	1	2	3	3	2	2	3			3			3	1
CO-5	1	2	3	3	2	2	3			3			3	1

Syllabus		
UNIT	**Contents**	**Mapped**

		COs
I	**Structure of Metals and Constitution of alloys:** Crystallization of metals, Packing Factor - SC, BCC, FCC & HCP- line density, plane density. Grain and grain boundaries, effect of grain boundaries – determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery's 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_3C.	**CO1**
II	**Ferrous metals and alloys:** Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheriodal graphite cast iron, Alloy cast iron. 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.	**CO2**
III	**Heat treatment of Steels:** Effect of alloying elements on Fe-Fe_3C system, annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.	**CO3**
IV	**Powder Metallurgy:** Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.	**CO4**
V	**Ceramic and Advanced materials**: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nanomaterials and smart materials.	**CO5**

Learning Resources
Text Book (s)
1. S.H.Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997. 2. Donald R.Askeland, Essentials of Materials science and Engineering, 4/e, CL Engineering publications, 2018.
Reference Book(s)

1. Dr. V.D.kodgire, Material Science and Metallurgy, 39/e, Everest Publishing House, 2017.
2. V.Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
3. William D. Callister Jr, Materials Science and Engineering: An Introduction, 8/e, John Wiley and Sons, 2009.
4. George E.Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.
5. Yip-Wah Chung, Introduction to Material Science and Engineering, 2/e, CRC Press, 2022.
6. A V K Suryanarayana, Material Science and Metallurgy, B S Publications, 2014.
7. U. C. Jindal, Material Science and Metallurgy, 1/e, Pearson Publications, 2011.

e- Resources & other digital material

1. https://archive.nptel.ac.in/courses/113/106/113106032/
2. https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior.
3. https://www.youtube.com/watch?v=9Sf278j1GTU
4. https://www.coursera.org/learn/fundamentals-of-materials-science
5. https://www.coursera.org/learn/material-behavior.