Semester - 2

INDUSTRIAL METALLURGY AND MATERIALS ENGINEERING

Course Code	Teaching hours per week				Self Study hours	Credits	Exam hours	Course type	CIE Marks	ESE Marks
	L	T	P	R	SS					
26NNMPC201	2	1	0	0	3.5	3	2 Hrs. 30 Min.	Theory	40	60

1. **Preamble:** This course introduces the importance of the microstructures and physical properties of the materials to enable the material selection process. This course also serves to develop an understanding of the basic principles of phase transformations and apply those principles to engineering applications.

2. **Pre requisites:** Nil

Module Number	Syllabus Description	Contact Hours
1	Introduction to material science: Classification of engineering materials, Structure of solids- Metallic, Ionic and covalent bonding. Properties based on atomic bonding. Crystallography: - SC, BCC, FCC structures, APF - theoretical density simple problems — Miller Indices: - crystal plane and direction - Modes of plastic deformation: - Slip and twinning	11
2	Mechanism of crystallization, Crystal imperfections — - Point defects, Line defects, Surface defects, Volume defects. edge and screw dislocations — Burger's vector — interaction between dislocations. Polishing and etching, Metallographic characterizations of metallic materials. SEM, TEM. Diffusion in solids, fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems. Applications of Diffusion.	11

3	Mechanical properties: Tensile properties, Hardness and hardness measurement, Impact properties, Fracture, DBTT, Fatigue, Creep, Super plasticity. Wear, corrosion -mechanism and types. Alloy steels and their applications. Properties and applications of composites, super-alloys and applications. maraging steel, Titanium	11
4	Phase diagrams: - need of alloying - classification of alloys – Hume Rothery's rule — equilibrium diagram of common types of binary systems: isomorphous (Cu- Ni) eutectic (Pb- Sn), lever rule and Gibb's phase rule. Detailed discussion on Iron- Carbon equilibrium diagram with microstructure and properties -Heat treatment: Chemical and Thermo mechanical heat treatment: - TTT, CCT diagram, applications - Tempering- Hardenability, Jominy end quench test, applications-Surface hardening methods.	11
	Total hours	**44**

3. Course Outcomes

At the end of the course students should be able to:

Course Outcomes		Blooms Taxonomy Level
CO1	Describe the crystal structures (BCC, FCC, and HCP) and correlate them with material properties.	**K2**
CO2	Explain the crystallographic defects through metallography.	**K2**
CO3	Compare the material properties and testing among different materials for material selection.	**K2**
CO4	Define and differentiate the microstructure of metallic materials using phase diagrams.	**K4**

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

4. Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	2	1	-	-	-	-	-	-
CO3	3	3	2	2	1	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination- 1	Internal Examination- 2	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3=24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9=36marks)**	**60**

5. **Text Books**

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Material Science and Engineering, 2014	Callister William D	John Wiley	8th Edition, 2010
2	Engineering Metallurgy part-I	Higgins R A	Arnold	6th Edition, 1993

6. **Reference Books**

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	The science and engineering of materials	Donald R Askeland	Cengage Learning	6th Edition, 2010
2	Introduction to Physical Metallurgy	Avner H Sidney	Tata McGraw Hill	2nd Edition, 1997 (Reprint 2009)
3	Material Science and Engineering	Raghavan V	Prentice hall	5th Edition, 2004
4	Mechanical Metallurgy	George E. Dieter	McGraw-Hill	3rd edition 2017

7. **Video Links or any other Reference Materials**

Sl No	Details Like Weblink, Publication Details	Module
1	https://archive.nptel.ac.in/courses/113/105/113105103/	All modules
2	https://spm-iitk.vlabs.ac.in/	2
3	https://mec-met-iitk.vlabs.ac.in/	3,4

MODEL QUESTION PAPER				
FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY(FISAT) (Autonomous) SECOND SEMESTER B. TECH DEGREE EXAMINATION (2026 Scheme), <Month & Year>				
Course Code: 26NNMPC201				
Course Name: Industrial Metallurgy and Materials Engineering				
Max. Marks: 60			Duration: 2 hours 30 minutes	
PART A				
		Answer all questions. Each question carries 3 marks	**CO**	**Marks**
1		Describe the types of atomic bonding in solids.	CO1	(3)
2		Explain BCC and FCC crystal structures.	CO1	(3)

3		Describe how Miller Indices are used to represent crystal planes and directions.	CO2	(3)
4		Discuss burger vector and burger circuit.	CO2	(3)
5		Discuss the features of ductile to brittle transition in materials.	CO3	(3)
6		Explain mechanism of fatigue failure.	CO3	(3)
7		Differentiate Austempering and Martempering process	CO4	(3)
8		Discuss the conditions that govern substitutional and interstitial solid solubility	CO4	(3)
PART B				
Answer any one full question from each module. Each question carries 9 marks				
Module 1				
9	a)	Explain SC, BCC, and FCC crystal structures with neat sketches. Derive the expression for theoretical density of a metal. Calculate the APF of FCC and compare it with BCC.	CO1	(9)
10	a)	Describe the procedure for determining Miller Indices for crystal planes and directions with suitable examples.	CO1	(5)
	b)	Distinguish between slip and twinning as mechanisms of plastic deformation.	CO1	(4)
Module 2				
11	a)	Explain Fick's first and second laws of diffusion with mathematical expressions. Describe the mechanisms of diffusion and discuss its engineering applications.	CO2	(6)
	b)	Describe the metallographic specimen preparation procedure.	CO2	(3)
12	a)	Explain the mechanism of crystallization. Describe point defects, line defects (edge and screw dislocations), surface defects, and volume defects in crystal structures with neat diagrams.	CO2	(9)
Module 3				
13	a)	Compare the mechanical properties of metals — tensile strength, hardness, toughness, fatigue, and creep. Describe the standard test methods used to evaluate each of these properties with neat sketches where applicable.	CO3	(9)
14	a)	Describe the types and properties of composites, super-alloys, maraging steels, and titanium alloys. Compare their advantages and list engineering applications of each.	CO3	(9)

Module 4				
15		Describe the Iron-Carbon equilibrium diagram in detail. Identify and explain all the invariant reactions (eutectic, eutectoid, peritectic). Using the lever rule, determine the phase composition and amounts in a hypoeutectoid steel. Construct and explain the TTT diagram for eutectoid steel.	CO4	(9)
16		Define and apply the Gibbs phase rule to the Cu-Ni isomorphous system. Describe the Pb-Sn eutectic phase diagram using Hume-Rothery's rules.	CO4	(9)
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