Ref. No.: Ex/PG/MET/PC/T/111/2025

M.E. METALLURGICAL ENGINEERING FIRST YEAR FIRST SEMESTER - 2025

Subject: MATERIALS SCIENCE

Time: 3 hours **Full Marks = 100**

(Answer All the Questions)	COs
1. Explain the any two terms with examples: (2.5 × 2 = 5) *a.* Bravais lattice *b.* Unit cell *c.* Coordination number **2. Calculate the atomic packing factor (APF) for: (Answer any two: 2.5 × 2 = 5)** *a.* Face-centered cubic (FCC) structure. *b.* Body-centered cubic (BCC) structure. *c.* Hexagonal close-packed (HCP) structure. **3. Sketch the following planes and directions in a cubic unit cell: (2.5 × 2 = 5)** *a.* (100), (110), (111) planes. *b.* [100], [110], [111] directions. **4. Explain how bond energy and bond length influence the following properties: (Answer any two: 2.5 × 2 = 5)** *a.* Melting point *b.* Electrical conductivity *c.* Mechanical strength. **5.** Explain why covalent bonds are directional, while metallic bonds are non-directional. How does this affect material behavior? **(5)**	CO1
6. Answer question "a" any three from others: (10 + 5 × 3 = 25) *a.* Classify crystal defects and explain their generation mechanisms. **(10)** *b.* Compare and contrast edge dislocations and screw dislocations using diagrams. **(5)** *c.* Describe the mechanism of dislocation motion (glide and climb) in crystalline materials. **(5)** *d.* A material has a dislocation density of $10^{12} m^{-2}$. If the total length of dislocations in a cubic crystal of side 1 mm is 10^6 m, calculate the volume of the crystal and verify the dislocation density. **(5)** *e.* Calculate the equilibrium concentration of vacancies in copper at 1000°C, given that the activation energy for vacancy formation is 0.9 eV and the pre-exponential factor is 5×10^{23} m^{-3}. Discuss how temperature affects the concentration of vacancies. **(5)**	CO2

[Turn over

7. Answer any two: (5 × 5 = 25) ***a.*** Define diffusion. Explain the Kirkendall effect and its significance in materials processing. ***b.*** Compare and contrast the mechanisms of vacancy diffusion and interstitial diffusion. ***c.*** Derive Fick's first law of diffusion and explain each term in the equation. ***d.*** Calculate the diffusion coefficient for a material at 800°C given that the pre-exponential factor $D_0=2\times10^{-5} m^2/s$ and the activation energy Q=150 kJ/mol. ***e.*** Discuss how temperature affects the rate of diffusion in crystalline materials. ***f.*** Discuss the role of diffusion in the formation of phase transformations (e.g., precipitation hardening) in alloys.	CO3
8. Answer any five: (5 × 5 = 25) ***a.*** Explain the difference between diamagnetic, paramagnetic, and ferromagnetic materials. Provide examples of each. ***b.*** Describe the concept of magnetic domains and how they contribute to the magnetization process. ***c.*** Explain the physical significance of the B-H loop and label its key features (saturation, remanence, coercivity). ***d.*** Explain the concept of hysteresis loss and its importance in the design of transformers. ***e.*** What are Bloch walls and Néel walls? How do they differ in terms of spin alignment? ***f.*** A paramagnetic material has a magnetization of 3×10^5 A/m$^3\times10^5$A/m when subjected to a magnetic field of 1.5×10^4 A/m. Calculate its magnetic susceptibility.	CO4