

**B.E Metallurgical and Material Engineering**  
**Second Year, Second Semester Examination 2022**  
**Subject: Materials Science**

Time: Three hours

Full Marks: 100

(Answer any five questions from the following taking at least two from each group)

**GROUP - A**

- 1(a). Draw a neat phase diagram for Fe-C system and write down all the invariant reactions for this system. 6 + 9 = 15
- (b) Write down the Gibbs phase rule and find the degrees of freedom in case of a binary isomorphous alloy within two-phase region. 2 + 3 = 5
- 2 (a) Find the amount of phases in the eutectic reaction product of Fe-C system. What is the name of this reaction product? Give reason for the incompleteness of "peritectic reaction" 3 + 2 + 3 = 8
- (b) Discuss the sequence of phase transformation processes and the evolution of different phases during cooling of a binary system containing iron and 0.4 wt pct carbon from molten state and mention the phases and the reactions involved, if any, during the course of cooling. 8
- (c) Find the amount of phases constituents in the reaction product obtained following eutectoid reaction in Fe-C system. 4
3. (a) Write down the rules for formation of extensive binary solid solution. 6
- (b) Unless otherwise stated, solid solutions are called "random solid solution" – Why? 3
- (c) What is your understanding about "crystalline materials?" Why are the crystalline materials "anisotropic?" How will you confirm whether a material is in crystalline form or not? 5 + 3 + 3 = 11
4. (a) Draw a binary phase diagram of A and B with the following information –
- Melting point of A: 660°C
  - Melting point of B: 1414°C
  - The system undergoes eutectic reaction at 577°C at B = 12.6 wt pct.
  - B forms a terminal solid solution with A with a maximum solid solubility of 1.65 wt pct B,
  - A has no solid solubility in B. 6
- (b) Write down the eutectic reaction for the phase diagram obtained in (a) above and find the amount of corresponding phases in the eutectic reaction product. 3 + 3 = 6
- (c) Write short notes on – (i) metallic bond; (ii) covalent bond 4 + 4 = 8

[ Turn over

**GROUP - B**

- 5 (a) What do you understand by “wave function,  $\psi$ ?” What is the necessity of  $|\psi^2|$  in wave mechanics? 5 + 3 = 8
- (b) What is the difference between a “mechanical wave” and wave connected with “wave mechanics”? 4
- (c) Derive the relationship for time independent form of Schrodinger’s wave equation. 8
6. (a) Show that the energy of a confined particle in a certain region in space is quantized. What general conclusions are drawn about the energy of such confined particle? 6 + 4 = 10
- (b) A marble weighing 10 gm is confined in a rectangular box of width 10 cm. Find the permitted energies. What conclusion can be drawn about the state of the marble? 5 + 5 = 10
7. (a) Discuss the Fermi Distribution function and state its importance. 5
- (b). A particle limited to the X-axis has the wave function  $\psi = ax$  between  $x = 0$  and  $x = 1$ ;  $\psi = 0$  elsewhere. Find the probability that the particle can be found between  $x = 0.45$  and  $x = 0.55$ . 5
- (c) Find the probability that a particle trapped in a box of width “L” can be found between  $0.45 L$  and  $0.55L$  for the first and first excited states. Also show your result by schematic plotting and comment. 10
8. (a) A uniform silver wire has a resistivity of  $1.54 \times 10^{-18}$  ohm/m at room temperature. For an electric field along the wire of 1 volt/cm. Compute the mobility, assuming that there are  $5.8 \times 10^{28}$  conduction electrons/m<sup>3</sup>. 6
- (b) State the assumptions made in Free Electron Theory and its limitations. 6
- (c) After deriving all the necessary relationship draw the E-K plot in terms of Free electron theory. 8