

INTRODUCTION TO PHYSICAL METALLURGY "——  
(MT-40I)

Time: 3 Hours

Full Marks: 70

Answer any five questions. All questions carry equal marks

1. (a) Draw the equilibrium diagram of a binary system which is completely miscible in the liquid state and partially soluble in solid state and shows a eutectic reaction. [5+3]
- (b) Draw the Fe-Fe<sub>3</sub>C phase diagram and discuss the cooling of an Fe-C alloy containing 0.55 wt% C and 1.2 wt% C from liquid state to room temperature.
- (c) Calculate the volume fraction of ferrite and cementite in a pearlite colony.
2. (a) Explain space lattice. What is the crystal system if  $a \neq b \neq c$  and  $\alpha \neq \beta \neq \gamma$  ?
- (b) Show that packing efficiency of an FCC is 0.74.
- (c) Draw a (111) plane in the unit cell of a cubic crystal. Show all the directions that lie on this plane, giving the Miller indices of each one of them.
- (d) Why is the solubility of carbon in austenite more than that of ferrite? [(3+1) + 4 \* 5 + 3]
3. (a) Explain different types of solid solution. Define the Hume-Rothery rules for substitutional solid solution.
- (b) What is the role of energy of the like bond and unlike bonds in solid solution?
- (c) What is the difference between heat etching and heat tinting? [(MM) + 3 \* 3]
4. (a) Draw composition-free energy diagram at eutectic temperature. Explain why the solubility is more in a phase which is in equilibrium with a metastable phase than with a stable phase.
- (b) Name the various types of crystal defects. What are the differences between edge and screw dislocation?
- (c) The diffusivity of silver atoms in solid silver metal is  $1.0 \times 10^{-17}$  m<sup>2</sup>/s at 500°C and  $7.2 \times 10^{-12}$  m<sup>2</sup>/s at 1000°C. Calculate the activation energy for the diffusion of Ag in Ag in the temperature range of 500-1000°C. [(3+3) + (2\*2) M]
5. (a) What is the difference between steady state and non steady state? How? Explain why interstitial diffusion is much faster than the substitutional diffusion.
- (b) Explain diffusion coefficient. Determine the diffusion coefficient using the Arrhenius equation.
- (c) Explain Kirkendall effect? [1(2+3) + 12+4) > 31]
6. Write short notes on (any four)
  - (a) Point defect
  - (b) Isomorphous System
  - (c) Intermediate phase
  - (d) Low angle and high angle grain boundary
  - (e) Slacking faults
  - (f) Eutectic and monotectic reactions
7. (a) How does an embryo differ from a nucleus during solidification? [3 \* 4]
- (b) Find out the critical radius and work for nucleation for the formation of a spherical nucleus from a liquid melt.
- (c) Define polymorphism with an example. [3 + 8 + 3]
8. (a) What is coring and when does it occur? How can you minimize coring?
- (b) Explain the etching mechanism of a duplex alloy.
- (c) What is spherical aberration and chromatic aberration of a lens?