

**Bachelor of Engineering (Mechanical Engineering) – Third Year – First Semester (Old)****Materials and Metallography**

Time: 3 hours

Full Marks: 100

**Answer any Five**

1. a) From the data given below for Bi-Cd system, plot the equilibrium diagram to scale and find:
  - i) Amount of eutectic in 20% Cd alloy and
  - ii) Free Cd in 70% Cd alloy

Given: Melting temperature of Bi= 271° C  
 Melting temperature of Cd= 321° C  
 Eutectic temperature of Bi= 144° C  
 Eutectic composition= 39.7% Cd

  - b) Describe recrystallization process.
  - c) What causes the decrease in hardness during the tempering of steel? **10+5+5**
  
2. a) What is ionic bonding?  
 b) What are the crystal structures for the following elements?  
     Au, Al, Mn,  $\gamma$ -Fe, Ni, Mg  
 c) Calculate the density of chromium from its lattice constant 'a'= 2.8845 Å and its atomic mass 52 gm/mole.  
 d) Find the number of atoms per mm<sup>2</sup> for chromium on (110) plane. **3+6+6+5**
  
3. a) Draw an approximate Iron-Iron carbide equilibrium phase diagram (Steel part only) according to scale and label it. Determine the amounts of the following phases present in 0.8% carbon steel under equilibrium conditions:  
     Austenite and cementite just above eutectoid temperature.  
 b) Explain the heat treatment process which is used to improve machine ability of high carbon steels. **12+8**
  
4. a) Describe the following cast irons:
  - i) Gray cast iron
  - ii) Malleable C.I.
  - b) Differentiate between hot working and cold working.
  - c) With neat sketch describe screw and edge dislocation. **8+6+6**
  
5. a) Distinguish between a substitutional solid solution and interstitial solid solution.  
 b) Show that the maximum radius of the sphere that can just fit into the void of FCC structure coordinate by facial atom is 0.414r, where 'r' is the radius of atom.

- c) Draw the following planes in different cubic unit cells.  
(321), (102), (112)
- d) Derive an equation for finding out the critical size of a nucleus for a pure silver when homogeneous nucleation takes place. **5+5+6+4**
6. a) Differentiate between a space lattice and a crystal.  
b) Define the term “atomic packing factor”. Calculate its value for FCC structure.  
c) How many atoms/mm<sup>2</sup> surface area are there in (110) plane for Copper which has FCC structure and a lattice constant  $a = 3.61 \times 10^{-7}$  mm.  
d) What is ordered solid solution? **5+5+5+5**
- 7) a) “Hardening of steel always followed by tempering”, is it true or false. If true, give reasons.  
b) Explain the homogenized annealing process.  
c) Differentiate between austempering and martempering.  
d) What is meant by ductile-brittle transition temperature? **5+5+5+5**
8. Write short notes on: (*Any four*) **5 x 4**
- a) Miller indices
  - b) T-T-T diagram (for eutectoid steel)
  - c) Solid state diffusion
  - d) Plastic deformation
  - e) Lever rule
  - f) Carburizing process
  - g) Metal ingot structure
  - h) Corrosion of metals
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