Bachelor of Engineering (Mechanical Engineering) - Second Year - First Semester

Material Science and Engineering

Time: Three hours | Full Marks: 100

Answer **any five** questions.
Sketches should be drawn by pencil only.

1. a) What is co-valent bonding and metallic bonding?
   b) What are the crystal structures for the following elements?
   Al, Cr, Mn, γ-Fe, W, V
   c) Calculate the density of chromium from its lattice constant. 'a' = 2.8845 Å and its atomic mass = 52 gm/mole. 8+6+6

2. a) Differentiate between a space lattice and a crystal.
   b) Define the term "atomic packing factor". Calculate its value for HCP structure.
   c) What is substitutional solid solution? 6+8+6

3. a) Melting point of Bismuth and Cadmium are 271°C and 321°C respectively. Eutectic composition will occur at 40% C_d and at 140°C. Draw the B_i-C_d equilibrium phase diagram according to scale and find the phases present for an alloy containing 80% C_d at 141°C and at 138°C and also find the amount of phases present.
   b) Describe edge dislocation. 12+8

4. a) Draw the Iron- Iron carbide equilibrium diagram according to scale and label it.
   b) A 0.8% C eutectoid steel is slowly cooled from 780°C to a temperature just below 723°C. Assuming that the austenite is completely transformed to α- ferrite and cementite:
   i) Calculate the weight percent eutectoid ferrite and weight percent eutectoid cementite formed. 12+8

5. a) Show that the maximum radius of the sphere that can just fit into the void of FCC structure coordinated by the facial atom is 0.414r, where "r" is the radius of the atom.
   b) Draw the following planes in different cubic unit cells.
   (321), (102), (112)
   c) Derive an equation for finding out the critical size of a nucleus for pure silver when homogeneous nucleation takes place. 6+6+8

6. a) Draw an approximate T-T-T diagram for an eutectoid steel.
   b) Compare between hot working and cold working.
   c) Write down the uses of eutectic alloys. 8+8+4

7. a) How malleable cast iron is produced? Give their uses.
   b) Why S.G.C.I. has more impact strength than Gray Cast Iron.
   c) Write down the effect of Sulpher, Phosphorous and Manganese on the properties of carbon steel. 8+4+8

8. a) Write the best suited material for the following applications:
   i) Leaf spring, ii) Lathe bed, iii) Razor blade, iv) Drill bit, v) Sewerage pipe
   b) Write short notes on **any three**:
   i) Austempering of steel, ii) Lever rule, iii) Tempering of steel, iv) Metal ingot structure, v) CCT diagram, vi) Plastic deformation 5+ 3X5