B.TECH/CHE/5TH SEM/CHEN 3133/2016

MATERIALS SCIENCE & ENGINEERING
(CHEN 3133)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Carbon content of steel is ----------%
(a) 0.1-2 (b) 4-6 (c) 2-4 (d) 0.001-0.01.

(ii) How many atoms are there per unit cell in a body centered cubic lattice?
(a) 2 (b) 3 (c) 4 (d) 6.

(iii) The ability of a material to offer resistance to scratching or indentation is a measure of its
(a) brittleness (b) toughness
(c) hardness (d) resilience.

(iv) The reaction that on heating one solid phase yields another solid phase and one liquid phase is called
(a) eutectic (b) peritectic
(c) eutectoid (d) peritectoid

(v) If the first reflection from an FCC crystal has a Bragg angle 21.5^0, the 2nd reflection will have the angle
(a) 18.5^0 (b) 25^0 (c) 31.2^0 (d) 36.8^0.

(vi) A material is called ductile, if it can be
(a) drawn into wires
(b) hammered into a thin sheet
(c) fractured without deformation
(d) made lustrous by heating it.

(vii) Leaching is a unit operation under
(a) electro-metallurgy (b) pyro-metallurgy
(c) hydro-metallurgy (d) none of these.

(viii) Thermal difference between calcinations and roasting is
(a) calcination is done in excess of oxygen and roasting is done in limited oxygen
(b) roasting is done in excess of oxygen and calcination is done in limited oxygen
(c) calcination is done in excess of oxygen and roasting is done in absence of oxygen
(d) calcination is used in oxide ores and roasting is done in sulphide ores.

(ix) Time dependent recoverable deformation is called
(a) elastic deformation (b) plastic deformation
(c) anelastic deformation (d) temporary deformation.

(x) Dislocations are sometimes called
(a) point imperfection (b) line imperfection
(c) surface imperfection (d) volume imperfection.

Group – B

2. (a) (i) Define space lattice and crystal structure
(ii) How many crystal systems and crystal structure can be generated in three-dimensional space?

(b) Derive the effective number of lattice points in the unit cell of the three cubic space lattices.

(2 + 6) + 4 = 12

3. (a) (i) What do you understand by Miller indices of crystal plane?
(ii) Narrate the systematic procedure for the determination of Miller indices of crystal plane.

(b) (i) Define packing factor.
(ii) Calculate the c/a ratio and packing factor for HCP crystals.
(iii) Prove that atomic packing factor of the FCC crystals structure is greater than that of the BCC crystal structure.

(2 + 3) + (2 + 2 + 3) = 12

Group – C

4. (a) (i) Define metallic bonding and in terms of that explain thermal & electrical conductivity of metals.

(ii) Describe the geometry of tetrahedral and octahedral voids in closed pack structure.

(b) X-ray analysis of a Mn-Si alloy with 75 atomic percent of Mn & 25 atomic percent of Si showed that the unit cell is cubic and the lattice parameter a = 2.86 Å. The density of the alloy is 6850 kg/m^3. Find the number of atoms in the unit cell and therefore identify the crystal structure.

(3 + 4) + 5 = 12

5. (a) (i) How would you classify crystal imperfections?
(ii) Define Burgers vector with reference to edge dislocation and skew dislocation.

(b) (i) Derive an expression for the equilibrium concentration of defects with the enthalpy of formation of such defects in a crystal.
(ii) Find the equilibrium concentration of vacancies in Copper at 0 K, 300 K and 900 K considering enthalpy of formation of vacancies (ΔHf) =120 kJ/mol.

(3 + 4) + (3 + 2) = 12

Group – D

6. (a) What are the degrees of freedom of a system of two components when the number of phases is one, two, three and so on. What would you infer from the calculated figures?

(b) Draw the iron-carbon phase diagram showing the different phase fields, and for 0.2% C-steel, name the phases and their fractions at equilibrium at the following temperatures as (i) just above 1493 ^{0}C, (ii) just below 1493 ^{0}C, (iii) just above 725^{0}C, & just below 725^{0}C.

6 + 6 = 12

7. (a) What are the differences between hardness and toughness of a material? How are they measured?

(b) Describe the anelastic behaviour of materials with the help of a model.

6 + 6 = 12

Group – E

8. (a) (i) What are the principles of hydrometallurgical processes?

(ii) Discuss briefly the outlines of the steps involved in hydrometallurgy with examples.

(b) (i) What are the chief sources of aluminum available in India?
(ii) How aluminium is commercially extracted from bauxite?

(2 + 4) + (2 + 4) = 12

9. (a) (i) What are the principles of Pyrometallurgy?
(ii) Discuss the smelting operation during copper extraction with the help of Cu-Cu_2S phase diagram.

(b) (i) Describe the basic principle of steel making in L-D converter.
(ii) What are the advantages of making steel in LD converter over open hearth process?

(2 + 4) + (2 + 4) = 12