

B.E. METALLURGICAL AND MATERIAL ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM – 2019

Subject: Material Science

Time: Three Hours

Full Marks: 30

(Answer any Five from the Following; All parts of a Question must be answered contiguously)

1. (a) What is the difference between a crystal and lattice? In tabular form state the parameters for designating all the Bravais Lattices. 2+3 = 5

(b) Find the number of atoms per unit cell and the packing density of Magnesium crystal. 4+4 = 8

(c) Define linear and planar density of atoms in case of crystalline structure. Find the planar density of atoms in case of (110) plane of FCC structure. 4+3 = 7

2. State the conditions for formation of extensive binary solid solution. What is meant by random solid solution? What is a superlattice? Give two examples of superlattices along with their crystal structure. What is electron compound? Give two examples of electron compound. Define Phase and how does a phase differ from mixture? 4+2+2+4+3+2+3 = 20

3. (a) Draw a binary phase diagram of two metals, A and B, having no solid solubility of A in B and limited solid solubility of B in A. Consider that A and B have complete solubility in each other in the liquid state. Give an example of such system and make a correspondence of the system with this phase diagram. 4+4 = 8

(b) Define Degrees of Freedom. Find the degrees of freedom at the lowest melting point of the above system of A and B (3a). 2+2 = 4

(c) Draw the Fe-Cementite phase diagram and identify different phase regions and the important composition and temperature. Why Fe-Cementite phase diagram is not called a true equilibrium diagram? 6+2 = 8

4. (a) Write down the peritectic reaction in case Fe-C system? Find the degrees of freedom in case of peritectic reaction. Why peritectic reaction does not go to completion? 2+2+3 = 7

(b) What is Lever Rule? Under what condition lever Rule is applicable? Find the amount of phases present in 0.6 wt pct plain carbon steel at room temperature. 2+2+3 = 7

(c) What are different types of void formed in BCC and FCC crystal structure? Find the size of these voids. 6

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5. (a) Niobium has an atomic radius of 0.1430 nm and a density of 8.57 g/cm³. Determine whether it has an FCC or BCC crystal structure.

(b) If the atomic radius of lead is 0.175 nm, calculate the volume of its unit cell in cubic meters.

(c) Calculate the radius of a tantalum atom, given that Ta has a BCC crystal structure, a density of 16.6 g / cm³, and an atomic weight of 180 g/mol.

(d) Why does solubility of carbon vary with the crystal structure of iron? 5+5+5+5 = 20

6. (a) Describe the crystal structure of Diamond and Graphite and enumerate the properties of these two forms of carbon. 5+5 = 10

(b) Find the atomic packing fraction of cubic diamond crystal structure. 5

(c) Find the ideal c/a ratio for HCP crystal system. 5

7. (a) Give an account for metallic bonding and covalent bonding. 5+5 = 10

(b) The net potential energy between two adjacent ions, E_N , is represented by the following equation

$$E_N = -\frac{A}{r} + \frac{B}{r^n}; \text{ where } A, B \text{ and } n \text{ are constants and } r \text{ is the distance between two adjacent ions.}$$

Calculate the bonding energy E_o in terms of parameters A, B and n. 6

(c) What is meant by ionic character of a solid and how it represented? 4