Ref. No.: Ex/Met/BS/B/T/224/2024

B.E Metallurgical Engineering
Second Year, Second Semester Examination 2024
Subject: Materials Science

Time: Three hours **Full Marks: 100**

Answers of Questions of any Group must be written in a common palce

GROUP – A
(Answer any two from the following)

Q1. (a) Draw a (111) plane and a (222) plane in the unit cell of a cubic lattice with lattice parameter a. Determine their distance from a parallel plane through the origin. **[CO1]** 8

(b) Find the family of crystal directions represented by the cube edges, face diagonals and body diagonals of a unit cube. Give the number of members in each family. Also write the Miller indices of each member of the three families. **[CO1]** 3 + 3 + 6 = 12

2. (a) Calculate the atomic density (number of atoms per unit area) in (111), (110) and (100) planes of copper (FCC) with lattice parameter 3.61 Å. **[CO1]** 10

(b) Find the Miller indices of a plane that makes intercepts on a, b and c axes equal to 3 Å, 4 Å and 3 Å in a tetragonal cell with c/a ratio 1.5. **[CO1]** 10

3. (a) Find the Miller indices of the line of intersection of a (-1 -1 1) and (-1 -1 -1) plane in a cubic crystal both geometrically and analytically? **[CO1]** 12

(b) X-rays of wavelength 1.54 Å are used to calculate the spacing of (200) planes of in aluminium. The Bragg angle for this refection is 22.4°.What is the size of the unit cell of the aluminium crystal. **[CO1]** 8

GROUP – B
(Answer any one from the following)

6. (a) Give an account for “bond energy”, “bond length” and “bond type” for chemical bonding. Explain thermal expansion behaviour in terms of bond length. **[CO2]** 10 + 5 = 15

(b) If the potential energy W of a system of two atoms varies as a function of their distance of separation r as follows find the equilibrium separation distance between two atoms.

$$W = -\frac{A}{r^n} + \frac{B}{r^m}$$ **[CO2]** 5

7. (a) What is known as crystal symmetry? Name five different symmetry operations and show with figure how these symmetry operations are performed. **[CO2]** 4 + 8 = 12

(b) Define the following terms: 8

(i) Centre of symmetry (ii) Rotoinversion axis of symmetry

(iii) $\bar{3}$ axis of symmetry (iv) Screw axis of symmetry

[Turn over

GROUP – C

(Answer any one from the following)

4. (a) Give the definition of 'Phase" and "Degree of freedom." **[CO2]** 2 + 2 = 4

(b) Draw a phase diagram with components A and B and where A has limited solid solubility in B, and B has no solid solubility in A. Label all the regions and write down the invariant reaction and find the "degree of freedom" of this invariant reaction, if present. **[CO2]** 5 + 3 = 8

5. (a) A steel microstructure contains 35 wt pct pearlite and rest ferrite. Find the amount of carbon in the steel. **[CO2]** 4

(b) What is a peritectectic reaction? Show that the reaction is invariant. Why is the reaction incomplete in nature? **[CO2]** 2 + 2 + 4 = 8

GROUP – D

(Answer any one from the following)

6. (a) According to Drude model find the relationship for thermal Conductivity in metals under conductive heat transfer condition. **[CO3]** 8

(b) A uniform silver wire has a resistivity of 1.54×10^{-18} ohm/m at room temperature. For an electric field along the wire of 1 volt/cm. Compute the mobility, assuming that there are 5.8×10^{28} conduction electrons/m^3. **[CO3]** 6

7. (a) After deriving all the necessary relationship draw the E-K plot in terms of Free electron theory. **[CO3]** 9

(b) A marble weighing 10 gm is confined in a rectangular box of width 10 cm. Find the permitted energies. **[CO3]** 5

GROUP – E

(Answer any one from the following)

8.(a) Discuss the origin of First Brillouin Zone. **[CO4]** 8

Or

(b) Discuss the origin of magnetic property of a material and the basis depending on which the magnetic property of different materials are classified. **[CO5]** **8**

(c) What is the magnetic domain? How do these domains behave with applied magnetic field? **[CO5]** **6**

Or

(d) Discuss the B-H loop and relate the loop shape with different types of magnetism in materials. **[CO5]** **6**