Tribhuvan University
2081
Bachelor Level (4 Yrs.)/Science & Tech. / IV year
Material Science — Full Marks: 100
PHY - 405 — Time: 3 hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.

Attempt ALL the questions.

1. What is metallic crystal? Find the atomic packing fraction of simple cubic (SC), face centered cubic (FSC) and body centered cubic (BCC) [10]

OR

What do you mean by extrinsic semiconductor? Discuss the temperature dependence of carrier concentration in case of P-tpe semi conductor. What are the factors affecting carrier mobility?

2. Define nanomaterials. Discuss size dependence properties of materials. State the reason of change of properties with size. [10]

OR

Define bulk' conductor, quantum well, quantum wire and quantum dot with one example of each. Discuss the methods of synthesis of nanoparticles.

3. Discuss the optical properties of nonmetals. [8]
4. Describe the processing of polymer (Plastics) [8]
5. Define diamagnetism, paramagnetism ferromagnetism and anti-ferromagnetism. Explain the magnetisation curve for soft and hard magnetic materials. [8]
6. Introduce phase diagram and describe binary phase diagram [8]
7. Answer all the questions. [2×3=6]
   a) What is point defect? Give two examples with appropriate figures.

   OR

   Distinguish between elastic and plastic deformations..
   b) Discuss thermal expansion of metal with examples.

   OR

How can we say that viscoelestic behaviour of polymer depends upon time and temperature?

8. Answer all the questions [4×3=12]

a. Highlight the manufacturing techniques on material science and engineering.

b. Define the terms ferroelectricity and piezoelectricity.

c. Mention the causes of fracture mechanism.

d. Write down the methods of synthesis of nanoparticles.

9. Calculate the minimum dimension of one dimensional infinitely deep potential well to confine a particle of energy of 10 eV. [Given $h = 6.62\times10^{-34}$ Js, $m_e = 9.11\times10^{-31}$kg] [5]

10. Compute the velocity of light in calcium fluoride (CaF_2) which has a dielectric constant of 2.056 at frequencies within the visible range. Given permeability in free space $\mu_0 = 4\pi\times10^{-7}$ Henrymeter and permittivity in free space $\varepsilon_0 = 8.854\times10^{-12}C^2N^{-1}m^{-2}$. [5]

11. Niobium has an atomic radius of 0.1430 nm and density of 8.57 g / cc. determine whether it has an FCC or BCC crystal structure. [5]

12. Calculate the equilibrium number of vacancies per cubic meter for copper at 1000^0C. The energy for vacancy formation is 0.9eV/atom, the atomic weight and density at 1000^0C for copper are 63.5 g/mol and 8.4 g/cc respectively. Given $N_A = 6.023\times10^{23}$ atoms/mol $K_B = 8.62\times10^{-5}$eV / k. [5]

13. For BCC iron, compute (a) the interplanar spacing, and (b) the diffraction angle for the 211 set of planes. The lattice parameter for iron is 0.2866 nm. Assume that monochromatic radiation having a wavelength of 0.1790 nm is used and the order of reflection is 1. [5]

14. A brass rod is to be used in an application requiring its end to be held rigid. The rod is stress free at 20^0C. Determine the maximum temperature to which the rod may be heated without exceeding a compressive stress of 200 MPQ. Given, modulus of elasticity 100 QPa for brass and coefficient of thermal expansion of brass = $20\times10^{-6}/\ ^0$C. [5]