B.Sc.(Honours) Examination, 2018

Semester–V

Physics (Honours)

Elective Course: BPE-3

(Material Science: Evolution and Applications)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***Question No. 1*** and any ***three*** from the rest.

1. Answer any ***five*** of the following questions : 2x5 = 10
   (a) Name the different groups of materials and discuss their uses. What is a perfect crystal?
   (b) Classify the following unit cell into proper crystal system : a=1.08 nm, b = 0.947 nm, c = 0.52 nm and $\alpha = 41^\circ$, $\beta = 82^\circ$, Write down the nearest neighbor distance in the case of bcc structure and the no. of atoms present in the unit cell of hcp structure.
   (c) If 0.28 nm is the spacing between the nearest neighbouring ions in NaCl lattice then write down its unit cell parameter.
   (d) How is a covalent bond formed in a hydrogen molecule? Explain why the molecule H_3 cannot be formed?
   (e) Obtain the distribution of atoms in (111) plane of a simple cubic crystal.
   (f) How does the intrinsic concentration of charge carriers in a semiconductor vary with the temperature? How does the mobility of charge carriers in a semiconductor depend on temperature?
   (g) What does the depletion region in an open circuited p-n junction contain?
   (h) Where does the Fermi level lie in an n-type semiconductor at 0K? What happens to the Fermi level if the density of donor atoms N_d is increased?

2. (a) Write down the expressions for electron and hole concentrations in an intrinsic semiconductor, assuming that $m_e^* = m_p^*$, show that the Fermi level lies in the mid-way between the valence band and the conduction band. Explain mass-action law and obtain the expression for the intrinsic carrier density.
   (b) How a p-n junction diode is produced? Explain the diffusion process and the 'potential difference' across the junction. What is depletion layer across the junction?
   (c) What happens when a p-n junction diode is (i) reverse biased (ii) forward biased externally? (6+3+1)

3. (a) What is nano structured material? Discuss how and why the selected properties of nano materials are different from that of bulk materials
   (b) Discuss the special features of composite materials. What are the different types of composite materials? Give examples. The volume fraction of plastics is 33.3%, the modulus of glass fibres is 6.9×10^4 MPa and that of polymers is 6.9×10^2 MPa. Calculate the Young's modulus of a composite with glass fibre reinforced in phenol formaldehyde plastics. (4+6)

P.T.O.

4 . (a). Define atomic packing factor. Obtain the atomic packing factors for Sc, Bcc, fcc lattices where the lattice constant is 'a' and atomic radius 'r'.

(b). Calculate the number of atoms per unit cell of a metal having a lattice parameter 0.29nm and density of 7870 kg/m^3 . Atomic weight of the metal is 55.85 .
(Given $N_A = 6.022 \times 10^{26} kmol^{-1}$) .

(c) . What are Miller indices? State the important features of the Miller indices of crystal planes. The Miller indices of a plane in a simple cubic crystal are (123). Get the coordinates of the plane. (4+2+4)

5.(a) . What do you mean by bonding in solids? Does it influence thermal expansion of solid? Name the different kinds of bonds in the materials.

(b) Discuss the salient features of ionic bonded crystal and how they are different from covalent bonded crystal?

(c) Identify the nature of bonding in (i) KCl (ii) Pb (iii) Ge (iv) CH_4 (v) Diamond (2.5+5+2.5)

6.(a) What is a point defect in crystal lattice? What are the different types of point defects and how are they caused?

(b).Obtain the equilibrium concentration of vacancies at a given temperature in a metallic Crystal. How does it vary with temperature? How is it modified for ionic crystals?

(c) What do you mean by anomalous behavior of water? (3+6+1)
