N 1101

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2004.

Second Semester

Bio-medical Engineering

PH 135 — MATERIAL SCIENCE

(Common to Electronics and Communication Engineering,
Metallurgical Engineering)

ime : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give the effect of dislocations on metals and superconductors with respect to electrical conductivity.

2. Calculate the lattice constant of iron if the atomic radii of the iron atoms in BCC and FCC are 1.258 Å and 1.292 Å respectively.

3. How does the electrical conductivity of aluminium vary with respect to addition of copper upto 5%?

4. The free electron density in sodium is 2.5×10^{28} m^{-3}. Calculate the fermienergy of sodium in eV at 0 K. Given $h = 6.626 \times 10^{-34}$ J.s and the electron's rest mass = 9.1×10^{-31} kg. The charge of electron = 1.6×10^{-19} coulomb.

5. Mention two important properties and two important applications of I_nP semiconductor.

6. Calculate the carrier concentration of electrons in n-type silicon at room temperature, if the conductivity is 3×10^4 ohm^{-1} m^{-1} and mobility of electrons is 1300×10^{-4} m^2/V–s.

7. Define energy product of a magnetic material.

8. Briefly explain the mechanism of zener breakdown in dielectrics.

9. What are traps? Give their importance in semiconductors.

10. Calculate the cutoff wavelength for silicon photodiode whose band gap energy is 1.1 eV.

PART B — (5 × 16 = 80 marks)

11. (i) Describe the construction and working of twisted nematic liquid crystal display system. (12)

(ii) What are fluorescence and phosphorescence? Briefly explain along with their applications. (4)

12. (a) (i) Deduce expressions for the packing factor of BCC and FCC crystal structures. (4 + 4)

(ii) Show that there is no five fold axis of symmetry in ideal crystals. (4)

(iii) Find the radius of the largest sphere that can fit in the largest interstitial void of crystalline iron at room temperature. (4)

Or

(b) (i) Distinguish between crystalline and non-crystalline materials. (4)

(ii) Describe the Debye-Scherrer powder method for determining the unit cell parameters of a crystal. (8)

(iii) Show that for a simple cubic lattice $d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}$. (4)

13. (a) (i) Mention two important features of classical and quantum free electron theories. (4)

(ii) Mention four high resistivity alloys along with their composition, properties and applications. (4 × 3 = 12)

Or

(b) (i) What are density of states? Derive an expression for density of states. Using that obtain an expression for fermienergy of a metal at 0 K. (8)

(ii) Give an account on High T_c superconductors and their applications. (8)

14. (a) (i) Obtain an expression for carrier concentration in a n-type semiconductor interms of donor concentration. (6)

(ii) Explain the variation of carrier concentration with respect to temperature in n-type semiconductor. (6)

(iii) Using a diagram, explain the variation of fermilevel with temperature and concentration in n-type semiconductor. (4)

Or

(b) (i) Give the theory of Hall effect. Discuss the nature of Hall co-efficient in various materials. (6)

(ii) Describe an experiment to determine the mobility of charge carriers using Hall effect. (6)

(iii) Mention four other applications of Hall effect. (4)

15. (a) (i) Mention four important ferrites and their applications. $(4 \times 1\frac{1}{2})$

(ii) What are reversible and irreversible domains? Based on that, explain the phenomenon of hysteresis in ferromagnetic materials. (3 + 3)

(iii) Define exchange energy and magnetostrictive energy. (4)

Or

(b) (i) Explain electronic polarisation. Mention its frequency and temperature dependence. (4 + 2)

(ii) Explain dielectric loss and the different factors favouring dielectric loss. (3 + 3)

(iii) Aluminium oxide is used as the dielectric in a capacitor. Its surface area and relative permittivity are 360 cm^2 and 8. Calculate the total electrical dipole moment induced in the oxide layer if a potential difference of 5 volt is applied across the capacitor (4)
