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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Second Semester

Electronics and Communication Engineering

PH 3254 – PHYSICS FOR ELECTRONICS ENGINEERING

(Common to: Electronics and Telecommunication Engineering)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Mention the lattice parameters of simple cubic and body centered cubic system.

2. Metallic iron changes from BCC to FCC structure at 910 °C and corresponding radius changes from 12.58 nm to 12.92 nm. What is the percentage of change in lattice constant?

3. Write any one drawback and success of classical free electron theory and quantum free electron theory, respectively.

4. What is meant by effective mass of an electron?

5. Calculate the conductivity of germanium after addition of boron at room temperature (300 K). Given the boron density and mobility to be $4.5 \times 10^{23}/m^3$ and 0.20 $m^2V^{-1}s^{-1}$, respectively.

6. Draw the energy band diagram of direct and indirect bandgap semiconductor and mention the difference between them.

7. Mention the reasons of optical loss and gain in optical materials.

8. How does optical amplification happen in diode lasers?

9. Draw the density of states for quantum wire and quantum well structures.

10. Define single electron phenomenon.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss briefly the crystal structure and atomic packing factor of face centered cubic and diamond cubic with neat diagram. (12)

(ii) Find the maximum radius of the interstitial sphere that can fit into the void at (½, ½, ½) between the atoms in the body centered cubic structure. (4)

Or

(b) (i) Describe the classifications of point defects and line defects in detail with neat diagram. (12)

(ii) Calculate the equilibrium concentration of point imperfections at 300 K in the case of copper. The enthalpy of formation of point imperfections is 120 kJ mol^{-1}. Gas constant = 8.314 kJmol^{-1}K^{-1}. (4)

12. (a) (i) Derive the expression for density of energy states and hence carrier concentration at any temperature and also give the expression for the Fermi energy of electrons at 0 K. (12)

(ii) Discuss briefly and show schematically, the Fermi distribution function at different temperatures. (4)

Or

(b) (i) Briefly discuss any three classifications of magnetic materials and their properties with relevant diagrams. (12)

(ii) A paramagnetic material has a magnetic field intensity of 10^6 A/m. If the susceptibility of the material at room temperature is 3.7×10^{-3}, calculate the magnetization and magnetic flux density in the material. (4)

13. (a) (i) Derive the expression for carrier concentration in an N-type semiconductors. (8)

(ii) Discuss briefly the variation of carrier concentration in n-type semiconductor with temperature. (4)

(iii) Find the resistance of an intrinsic Ge rod 1 cm long, 1 mm wide and 1 mm thick at 300 K. For Ge, $n_i = 2.5 \times 10^{19}$ /m^3, $\mu_e = 0.39$ m^{2}V^{-1}s^{-1} and $\mu_e = 0.19$ m^{2}V^{-1}s^{-1}. (4)

Or

(b) (i) Discuss briefly the ohmic and Schottky contacts with energy band diagram and explain the I-V characteristics of Schottky diode under forward and reverse bias condition. (6+6 = 12)

(ii) Consider a Schottky junction diode between tungsten (W) and n – silicon doped with 10^{16} donors per cm^3 with work function of metal greater than semiconductor. What is the energy required for the electron to move from E_c to E_{fn}?

Given: $N_c = 2.8 \times 10^{19}$ per cm^{-3}. (4)

14. (a) (i) Explain about the classification of optical materials with respect to either wavelength or frequency of absorption or scattering. (12)

(ii) Calculate the energy of the electron and heavy hole produced by absorbing a 1.5 eV photon in InP? (Given: ε_g of InP = 1.35 eV, $m_e^* = 0.082\ m_o$, $m_{hh}^* = 0.085\ m_o$ and $m_r o = 0.075 m_o$. (4)

Or

(b) (i) Explain the construction, operation principle, energy band diagram and light emission characteristic of heterojunction diode Laser with schematic. (12)

(ii) The laser photons of wavelength 540 nm falls on a solar cell with its spot diameter of 2 mm. Calculate the light intensity and number of photons falling per second on the device. (4)

15. (a) (i) Explain briefly the density of energy states for quantum well, quantum wire and quantum dot in case of semiconductors with schematic. (12)

(ii) Discuss ballistic transport in semiconductor. (4)

Or

(b) (i) What is spintronics? Explain briefly the construction and operation of spintronic devices along with applications. (10)

(ii) Write short note on quantum well lasers. (6)
