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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

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 × 2 = 20 marks)

1. What is the difference between primitive cell and unit cell?

2. Copper has FCC structure with its lattice parameter of 0.3615 nm. Find the interplanar spacing of (2, 2, 2) plane.

3. Calculate Lorentz number for copper at 293 k, if the electrical conductivity and thermal conductivities are $1.72 \times 10^{-8}\ \Omega$ m and 386 W/mK respectively.

4. Draw the energy band diagram of Schottky contact for a metal with work function greater than that of n-type semiconductor.

5. Draw the energy band diagram of n and p-type semiconductors before and after the junction is made under thermal equilibrium.

6. Calculate the conductivity of intrinsic germanium at room temperature (300 K) using the following data : $n_i = 2.4 \times 10^{19}/m^3$ $\mu_e = 0.39\ m^2V^{-1}s^{-1}$ and $0.19\ m^2V^{-1}s^{-1}$.

7. Is direct bandgap semiconductors used for fabrication of optical devices? Comment on it.

8. Draw the energy band diagram of Organic LED and label it.

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

10. Discuss about quantum conductance.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss briefly about simple and closed packed hexagonal structure and calculate the c/a ratio and packing factor of the HCP with neat diagram. (10)

(ii) The height of the HCP unit cell is 0.494 nm and the nearest neighbor distance is 0.27 nm. The atomic weight of zinc is 65.37. Calculate the volume of the unit cell. (6)

Or

(b) (i) Discuss briefly the crystal directions and Miller indices with its procedures to represent (100), (110), (111) and (200) planes of a cubic crystals. (10)

(ii) Show the expression for separation between two lattice planes in a crystal with schematic. (6)

12. (a) Derive the expression for thermal conductivity and electrical conductivity and obtain the relation between them using classical free electron theory. (16)

Or

(b) (i) Briefly discuss the origin of ferromagnetism and exchange interaction in ferromagnetic materials. (12)

(ii) The saturation magnetic induction of nickel is 0.65 wb/m^2. If density of nickel is 8906 kg/m^3 and its atomic weight is 58.7, calculate the magnetic moment of the nickel atom in Bohr magneton. (4)

13. (a) (i) Briefly discuss the origin of energy bands in semiconductors with schematic and differentiate between direct and indirect band gap semiconductors with necessary diagrams. (6 + 6 = 12)

(ii) In a p-type germanium, $n_i = 2.1 \times 10^{19} m^{-3}$, density of boron $= 4.5 \times 10^{23}$ atoms m^{-3}. The electron and hole mobilities are 0.4 and 0.2 m^2/volt-s, respectively. What is it's conductivity before and after the addition of boron atoms? (4)

Or

(b) (i) Discuss Hall effect and derive the expression for Hall coefficient and draw experimental setup to determine Hall mobility of semiconductor. (6 + 6 =12)

(ii) A semiconducting crystal 12 mm long, 5 mm wide and 1 mm thick has a magnetic flux density of 0.5 wb/m^2 applied from front to back, perpendicular to largest faces. When a current of 20 mA flows length wise through the specimen, the voltage measured across its width is found to be 37 μV. What is the Hall coefficient of this semiconductor? (4)

14. (a) (i) Explain briefly about optical absorption in quantum well along with energy band diagram in the presence and absence of a transverse electric field in semiconductor. (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, $m_e^* = 0.082m_o$, $m_{hh}^* = 0.085m_o$ and $m_r o = 0.075m_o$. (4)

Or

(b) (i) Describe briefly the principle of operation and I – V characteristic of Photovoltaic device with neat diagram. (12)

(ii) The light intensity of 700 W/m^2 falls on a solar cell having the surface area of 0.03m × 0.03m, the resultant current and voltage generated are 157 mA and 475 mV, respectively. Calculate the efficiency of the photovoltaic device. (4)

15. (a) (i) What happens to the energy, momentum and position of an electron in an isolated thin semiconductor when it is quantum confined along one dimension ie., quantum wells? (10)

(ii) Discuss briefly the bandgap of nanomaterials of conductors, semiconductor and insulators. (6)

Or

(b) (i) What are carbon nanotubes (CNTs)? Explain briefly the properties and applications of CNTs with neat diagram. (10)

(ii) Discuss briefly about spintronic devices and its applications. (6)