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May-2026

B.Sc.-II SEMESTER

Basic Semiconductor Physics (PHU-110-V)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) Calculate the energy in ground state for an electron in 1D box of length 2A. (1.5)

(b) Differentiate between direct and indirect semiconductors? (1.5)

(c) What is meant by knee voltage, when p-n junction is forward biased. (1.5)

(d) Define effective mass and write the expression for effective mass of an electron. (1.5)

(e) Why is temperature co-efficient of resistance negative for semiconductor? (1.5)

(f) Plot the curve showing functional dependency of density of state on energy for OD, ID, 2D and 3D materials. (1.5)

(g) Show that for one dimensional problem the average kinetic energy of electron is one third the Fermi energy. (1.5)

(h) Define the term drift velocity. (1.5)

(i) Calculate the energy of Fermi level if 2×10^7 electrons are confined on a box of unit cm length. (1.5)

(j) Differentiate between degenerate and non-degenerate semiconductors. (1.5)

PART–B

2. (a) Explain Fermi-Dirac distribution function. Plot the function for various temperatures including 0K. Also approximate the Fermi function using Maxwell-Boltzmann statistics. (5)

(b) What are intrinsic semiconductors? Obtain the expression for electron concentration in conduction band for intrinsic semiconductor. (10)

3. (a) Show that concentration of electrons in the conduction band of an n-type semiconductor is proportional to square root of donor concentration. (10)

(b) Discuss charge carrier generation and recombination. (5)

4. (a) Discuss the motion of electron in the periodic field of a crystal using Kronig-Penny model and also explain the formation of bands on solids. (10)

(b) What are Brillouin zones? Discuss the Brillouin zones for 1D and 2D lattice. (5)

5. (a) What are the salient features and drawbacks of classical free electron theory? Derive an expression for electrical conductivity in a metal? (10)

(b) For the metal having 6.5×10^{28} conduction electron/m^3. Find the relaxation time of conduction electrons if the metal has resistivity 1.43×10^{-8} Ω, m.

Given $m = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C. (5)

6. (a) Show that for an intrinsic semiconductor Fermi level lies midway between conduction and valance band. (10)

(b) Differentiate between Ohmic contact and Schottky barriers injunction diodes. (5)

7. Write short note on :

(a) Light emitting diode. (5)

(b) p-n junction. (5)

(c) Law of mass action. (5)