

**004101****April 2022****B.Tech. (CSE/IT) - I SEMESTER****Physics (Semiconductor Physics) (BSC-101D)****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) What are the limitations of free electron theory? (1.5)
- (b) What is the change in the shape of E-k curve when potential barrier strength is zero? (1.5)
- (c) What do you understand by the term band gap? (1.5)
- (d) Prove that for intrinsic semiconductor Fermi energy level lies midway to the bandgap. (1.5)
- (e) Give two examples of each direct and indirect bandgap semiconductors. (1.5)

- (f) Differentiate between diffusion and drift mechanism for flow of electrons. (1.5)
- (g) What do you mean by knee voltage when PN junction diode is in forward bias? (1.5)
- (h) In 100 nsec a pulse of  $8 \times 10^6$  photons of wavelength 1300 nm falls on a photo detector. On an average  $6.4 \times 10^6$  electron hole pairs are generated. What is the quantum efficiency of photo detector? (1.5)
- (i) What do you understand by optoelectronic devices? Give two examples. (1.5)
- (j) Explain the structure of buckyballs. (1.5)

#### PART-B

2. (a) What is the effect of periodic potential on the energy of electrons in a metal? Explain it on the basis of Kronig-Penney model and explain the formation of energy bands. (10)
- (b) Define effective mass. Prove that it is dependent on energy and wave vector. (5)
3. (a) Draw the energy band diagram of a metal semiconductor junction and label the important quantities such as Fermi level, band bending, etc. (7)

- (b) For intrinsic semiconductor with a gap width of 1 eV calculate the position of Fermi level at  $T = 0^\circ \text{K}$  and at  $T = 300^\circ \text{K}$  if  $m_h^* = 6 m_e^*$  where  $m_h^*$  and  $m_e^*$  are effective masses of hole and electrons respectively. Boltzmann constant  $k = 1.4 \times 10^{-16} \text{ ergs}/0^\circ \text{K}$ . (8)

4. (a) Explain four probe methods. Derive an equation to calculate resistivity of a thin semiconductor. (7)
- (b) Distinguish between metals, semiconductors and insulators using band theory. (8)
5. (a) Explain photovoltaic effect. With required diagrams discuss construction and working of solar cell. (5)
- (b) What is radiative and non-radiative transition? Explain in brief the optical joint density of states. (10)
6. (a) Define following terms with respect to Light-semiconductor devices. (i) Absorption of radiation. (ii) Spontaneous emission (iii) Stimulated emission (iv) Meta stable state. (10)
- (b) Discuss UV-VIS method for band gap measurement of semiconductors. (5)



What do you mean by Density of state? Give its physical significance. Compare the density of state function for zero-, one- and two-dimensional system. (15)

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