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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 8×10^6 photons of wavelength 1300 nm falls on a photo detector. On an average 6.4×10^6 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° K and at T = 300° K if $m^*_h = 6\ m^*_e$ where m^*_h and m^*_e are effective masses of hole and electrons respectively. Boltzmann constant $k = 1.4 \times 10^{-16}$ ergs/0°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)

7. 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)
