Bihar Engineering University, Patna

B.Tech. 2nd Semester Special Examination, 2024

Course: B.Tech. *Time: 03 Hours*

Code: 105201 *Subject: Physics (Semiconductor Physics)* *Full Marks: 70*

Instructions:-

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

Q.1 ***Answer the following questions (any seven only):*** **[2 x 7 = 14]**

(a) What is the unit of mobility of charge carriers?

(b) Give examples of direct band semi-conductor.

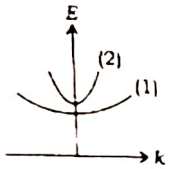
(c) Define Fermi level.

(d) What do you mean by diffusion in carrier transport?

(e) Write two advantages of LED over ordinary incandescent lamp.

(f) Explain in brief, what are intrinsic semiconductors.

(g) The E-k diagram for two materials (1) and (2) have been shown below:



Which one will have larger effective mass?

(h) What is Heisenberg uncertainty principle?

(i) What are phonons?

(j) What is phase velocity?

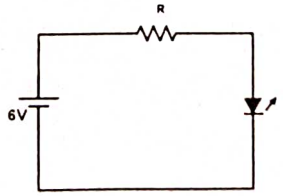
Q.2 (a) Explain the variation of carrier concentration with temperature inside a semiconductor. **[7]**

(b) Explain the structure and working of a semiconductor laser. **[7]**

Q.3 (a) Derive the expression for equilibrium concentration of electrons in conduction band. **[7]**

(b) For a uniformly doped Si sample with $N_A=10^{16}$ cm^{-3} and $N_D = 2x10^{16}$ cm^{-3}, determine the equilibrium electron and hole concentrations at room temperature. **[7]**

Q.4 (a) In the circuit shown below, the forward biased LED has a voltage drop of 1.5 V: **[7]**



If the battery voltage is 6 V, then calculate the resistance to be connected to the circuit, if the current through the LED is 15 mA. How much power is dissipated in the resistor?

(b) A GaAs LED radiates at 900 nm. If the forward current in the LED is 20 mA, calculate the power output, assuming an internal quantum efficiency of 2%. **[7]**

Q.5 In an intrinsic semiconductor with $E_g = 0.7$ eV, determine the position of Fermi level at T=300 K if $m_p^* = 6m_e^*$. Also calculate the density of holes and electrons at 300 K. How do these quantities alter if $E_g = 7$ eV. **[14]**

Q.6 He effective mass of the conduction electron is Si is 0.31 times the free electron mass. Find the conduction electron density at 300 K, assuming that the Fermi level lies exactly at the center of the energy band gap (=1.11 eV). **[14]**

Q.7 Discuss the wave –particle duality of light. What is the difference between photoelectric effect and the Compton effect? Explain how does the Compton effect show the wave particle duality of light. **[14]**

Q.8 Derive an expression for effective mass of an election. What is the significance of negative effective mass? **[14]**

Q.9 Write short notes on ***any two*** of the following: **[7 x 2 = 14]**

(a) Density of states
(b) Free electron model
(c) P-n junction