



SNS COLLEGE OF ENGINEERING

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AN AUTONOMOUS INSTITUTION



Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai.

UNIT -III SEMICONDUCTOR PHYSICS

TOPIC – IX PROBLEMS DISCUSSION

1. Calculate the intrinsic concentration of charge carriers at 300 K given that $m_e^* = 0.12m_o$, $m_h^* = 0.28m_o$ and the value of band gap = 0.67 eV. Solution:

Given:

$$m_e^* = 0.12m_o = 0.12 \times 9.1 \times 10^{-31} = 1.092 \times 10^{-31} \text{Kgm}^{-3}$$

$$m_h^* = 0.28m_o = 0.28 \times 9.1 \times 10^{-31} = 2.548 \times 10^{-31} \text{Kgm}^{-3}$$

$$T = 300\text{K.}$$

Intrinsic carrier concentration is given by,

$$n_i = 2 \left[\frac{2\pi kT}{h^2} \right]^{3/2} (m_e^* m_h^*)^{3/4} \exp \left[\frac{-E_g}{2K_B T} \right]$$

$$2 \left[\frac{2\pi kT}{h^2} \right]^{3/2} = 2 \left[\frac{2\pi \times 1.38 \times 10^{-23} \times 300}{6.626 \times 10^{-34}} \right]^{3/2}$$

$$= 2 (1.4421 \times 10^{70})$$

$$= 2.884 \times 10^{70}$$

$$(m_e^* m_h^*)^{3/4} = (1.092 \times 10^{31} \times 2.548 \times 10^{-31})^{3/4}$$

$$= 6.813 \times 10^{-47}$$

2. For an intrinsic Semiconductor with a band gap of 0.7 eV, determine the position of E_F at $T = 300$ K if $m^*_h = 6m^*_e$.

Solution:

$$\text{Bandgap } E_g = 0.7 \text{ eV} = 0.7 \times 1.6 \times 10^{-19} \text{ V}$$

$$T = 300 \text{ K}$$

Fermi energy for an intrinsic semiconductor

$$E_F = \frac{E_g}{2} + \frac{3KT}{4} \log \left[\frac{m_h^*}{m_e^*} \right]$$

$$E_F = \left[\frac{0.7 \times 1.6 \times 10^{-19}}{2} \right] + \left[\frac{3 \times 1.38 \times 10^{-23} \times 300}{4} \right] \log_e 6$$
$$= 6.1563 \times 10^{-20} \text{ Joules}$$

$$E_F = \frac{6.1563 \times 10^{-20}}{1.6 \times 10^{-19}}$$