CT3 SD

Aditya Singh

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1. a) As electrons diffuse across the junction a point is reached where the negative charge repels any further diffusion of electrons, potential difference required to move electrons through electric field is barrier potential

$$\frac{n_p}{n_n} = \frac{p_n}{p_p} = \exp\left(\frac{-eV_0}{KT}\right)$$

$n_n = N_D$, $n_p = \frac{n_i^2}{N_A}$ $N_A \rightarrow$ conc^n of acceptors

$$V_0 = \frac{K_B T}{e} \ln\left(\frac{N_A N_D}{n_i^2}\right)$$ $N_D \rightarrow$ conc^n of donors

b) $V_0 = \frac{K_B T}{e} \ln\left(\frac{n_a n_D}{n_i^2}\right)$, $\frac{n_i^2}{n_A} = \frac{\cancel{2.25}(1.5\times10^{10})^2}{10^8}$

$= 0.026 \ln\left(\frac{10^{15}}{2.25\times10^2}\right)$ $= 2.25\times10^2$.

$= 0.757$ volts.

2. a) Compensated Semiconductor $\rightarrow$ a semiconductor in which donors and acceptors are related in such a way that their opposing electrical effects are partially cancelled.

Charge neutrality is expressed by equating the density of negative charges to that of positive,

$$n_0 + N_a^- = p_0 + N_d^+$$

$$n_0 + (N_a - P_a) = p_0 + (N_d - n_d)$$

where n_0, p_0 are thermal-equilibrium concn of electron and holes,

assume ionisation,

$$n_0 + N_a = p_0 + N_d \quad (n_d = 0, p_a = 0)$$

$$n_0 + N_a = \frac{n_i^2}{n_0} + N_d$$

$$n_0^2 - (N_d - N_a) n_0 - n_i^2 = 0$$

$$n_0 = \frac{(N_d - N_a)}{2} + \sqrt{\left(\frac{N_d - N_a}{2}\right)^2 + n_i^2}$$

b) $$\frac{D_p}{\mu_p} = \frac{KT}{q}$$

$$\frac{D_p}{1000} = 26\ m$$

$$D_p = 26000\ m\ cm^2/s$$

$$D_p = \underline{\underline{26\ cm^2/s}}.$$

$\boxed{3}$ Density of state function gives number of energy states available for the electron to occupy in an energy band. It is the no. of states available per unit volume.

$$E \xrightarrow[dE]{} E + dE, \quad N(E)\, dE = \frac{\pi}{2} n^2\, dn.$$

$$E = \frac{n^2 h^2}{8mL^2}, \quad n = \sqrt{\frac{8mL^2E}{h^2}}$$

$$2n\,dn = \frac{8mL^2}{h^2} dE$$

$$dn = \left(\frac{1}{2n}\right)\left(\frac{8mL^2}{h^2}\right) dE$$

$$dn = \frac{1}{2}\left(\frac{8mL^2}{h}\right)^{1/2} \frac{dE}{E^{1/2}}$$

$$Z(E)\,dE = \frac{\pi}{2} \times \frac{8mL^2E}{h^2} \times \frac{1}{2}\left(\frac{8mL^2}{h^2}\right)^{1/2} \frac{dE}{E^{1/2}}$$

$$\boxed{Z(E)\,dE) = \frac{2\pi}{h^3}(2m)^{3/2} L^3 E^{1/2}\,dE}$$

b) $N_v = 1.04 \times 10^{25}\left(\frac{400}{300}\right)^{3/2} = 1.6 \times 10^{25}/m^3.$

$KT = 0.0259\left(\frac{400}{300}\right) = 0.03453\ eV$

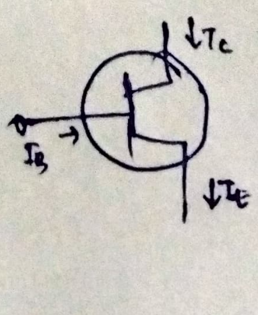
$$p = N_v \exp\left(-\frac{E_F - E_v}{KT}\right)$$

$$= 1.6 \times 10^{25}\, e^{\left(\frac{-27}{0.03453}\right)}$$

$$= 6.43 \times 10^{19} / m^3$$

4

In BJT, operation is dependent on both the charge carriers. offset voltage is required, and consumption of power is more, gain is more.



In FET, the operation performed is due to the majority of carriers, no requirement for its voltage control. consumption of power is less and lesser the gain, lesser the value of output impedence.

b) $\alpha = 0.95$, $I_E = \frac{2}{3000}$

$$\alpha = \frac{I_C}{I_E}$$

$$I_C = \alpha I_E = 0.95 \times \frac{2}{3000}$$

$$I_E = I_B + I_C$$

$$I_B = I_E - I_C = \frac{2}{3000} - \frac{0.95 \times 2}{3000}$$

$$= \frac{2}{3000}(1 - 0.95)$$

$$= 0.033 \text{ mA}$$