Roll no:- 2150

Modern College of Engineering

Shivajinagar, Pune 5.

Div - L,

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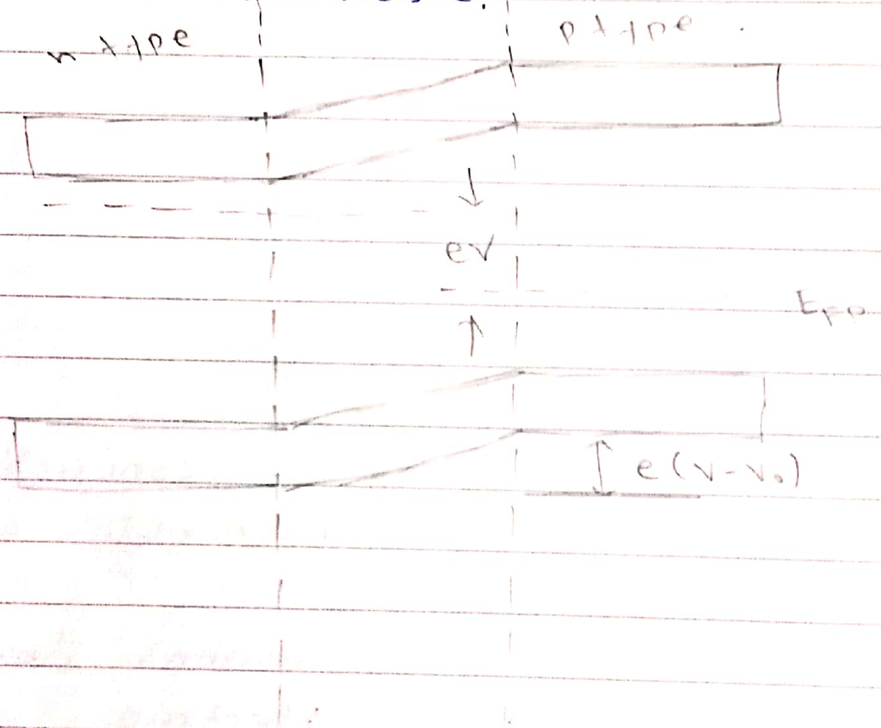
Assignment no :- 9.

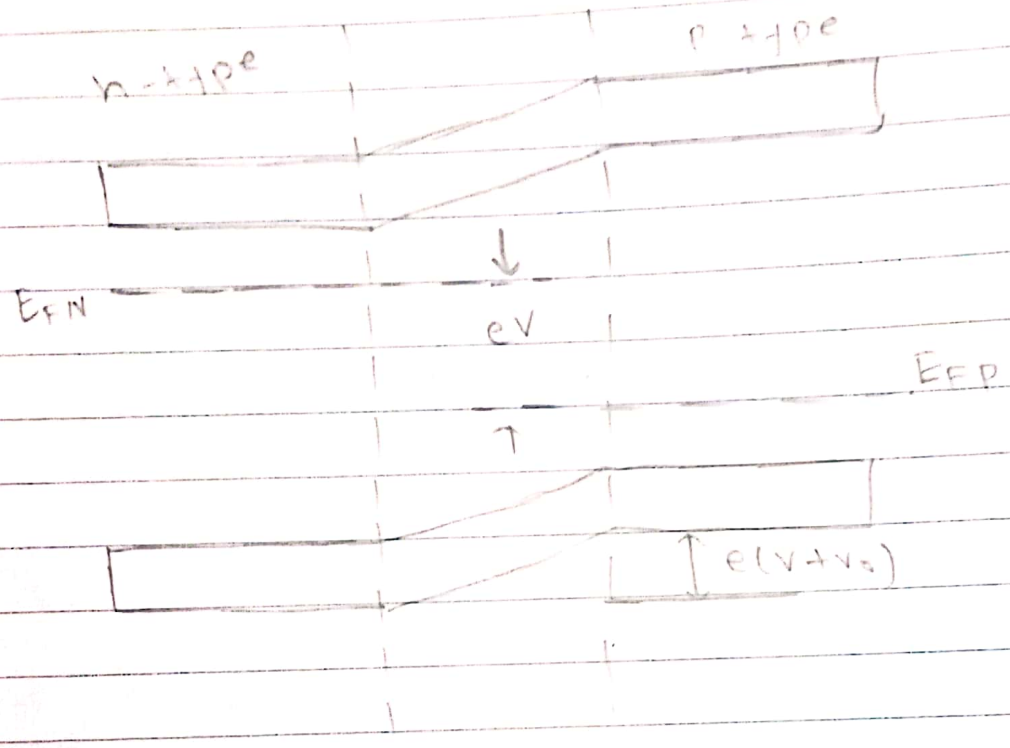
1. Draw energy band diagram of forward and reverse biased P-N junction diode.

Ans.

i) Forward biased



ii) Reverse Biased



2] Derive conditions for conductivity for an intrinsic and extrinsic semiconductor

Soln.

~~Let~~ ~~J~~ — ~~Current density~~.
~~E~~ - ~~Electric~~ fie

i) For intrinsic semiconductor.

$I = I_e + I_h$

we know that.

$I_e = e n_e A v_e$

$I_h = e n_h A v_h$

$\therefore I = n_e e A v_e + n_h e A v_h$

$I = eA[n_e v_e + n_h v_h]$

$\therefore \frac{I}{A} = e[n_e v_e + n_h v_h]$ —①

We also know that,

$R = \frac{\rho l}{A}$ and $E = \frac{V}{l}$

$\therefore \rho = \frac{RA}{l}$

$\therefore \frac{E}{\rho} = \frac{V}{RA}$

$\frac{E}{\rho} = \frac{I}{A}$ —②

$\therefore$ from ① and ②

$\frac{E}{\rho} = e[n_e v_e + n_h v_h]$

We know

$\frac{1}{\rho} = \sigma$ and $\frac{v_d}{E} = \mu$

$\therefore \sigma = e\left[n_e \frac{v_e}{E} + n_h \frac{v_h}{E}\right]$

$\therefore \sigma = e[n_e \mu_e + n_h \mu_h]$

ii) For extrinsic.

a) For p-type.

holes are in majority.

$\therefore \quad \sigma = e n_h \mu_h$.

b) For n-type.

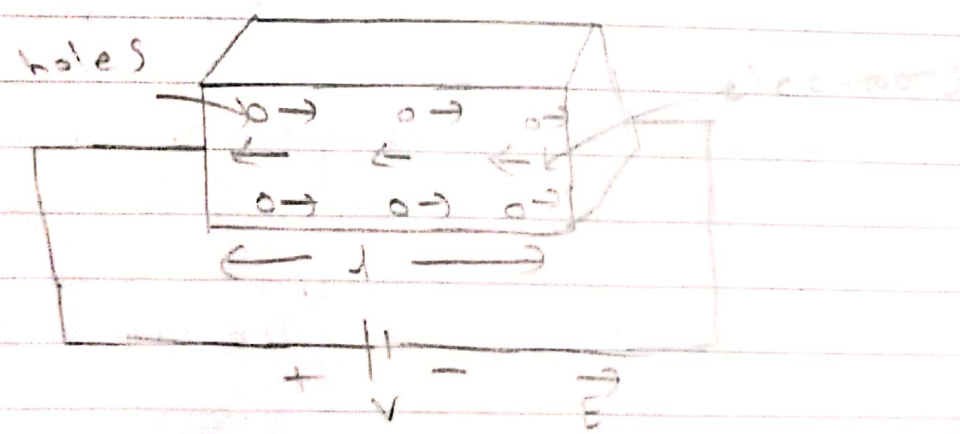
electrons are in majority.

~~∴ electrons are in majority.~~

$\therefore \quad \sigma = e n_e \mu_e$.

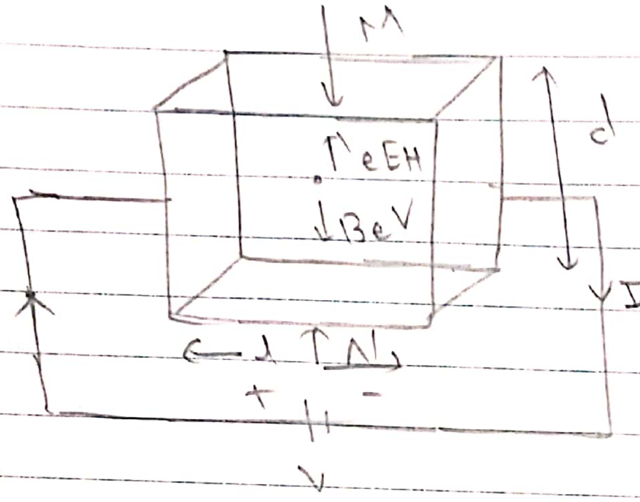
where.

e = charge on electron
n = no. of electrons per cross section.
μ = mobility.



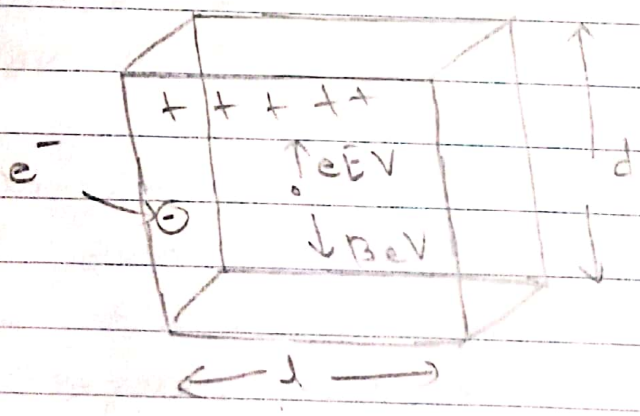
3] Derive an expression for Hall voltage and Hall coefficient.

Ans. I]

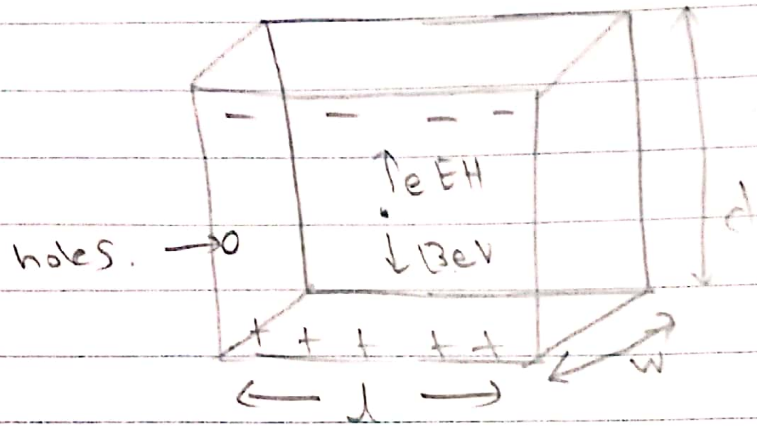


l = length, B = Magnetic field.
d = thickness
e = electronic charge
w = width, v = velocity of particle

II]



N-type semiconductor



III) If a piece of conductor carrying current is placed in transverse magnetic field and electric field is produced inside the conductor in a direction normal to both current and magnetic field. This phenomenon is called Hall effect and the voltage so generated is Hall voltage.

iv) Assume n-type semiconductor in which current flows from right to left if V is drift velocity of electrons moving perpendicular to magnetic field 'B'. there is downward force BeV acting on each electron to be deflected in downward direction and keep the positive ion on top surface. This gives rise to potential difference along top and both faces cause a electric field E_H in negative y -direction.

v] Under equilibrium condition, for force due to electric field and magnetic field.

$$eE_H = BeV \quad --(1)$$

$$E_H = BV \quad -(2)$$

$$V = \left[\frac{I}{neA}\right] \quad --(3)$$

Replace (3) in (2)

$$E_H = \left[\frac{BI}{neA}\right]$$

$$\therefore E_H = \left[\frac{V_H}{d}\right]$$ [Electric field due to potential difference across thickness d.]

$$V_H = E_H d.$$

$$V_H = \left[\frac{BId}{neA}\right]$$

$$V_H = R_H\left[\frac{BId}{A}\right]$$

VI. Now, $R_H = \frac{1}{ne}$ = Hall coefficient.

$$A = d \times w.$$

$$V_H = \left[\frac{BId}{neA}\right].$$

If charge separation is along width then d is replaced with ω.

$$V_H = \frac{BIW}{neA}.$$

$$\Rightarrow = \frac{BId}{n \times e \times d \times w}.$$

$$\therefore V_H = \left[\frac{BI}{new}\right]$$

For wholes.

$$V_H = \left[\frac{BIw}{neA}\right]$$

—||—