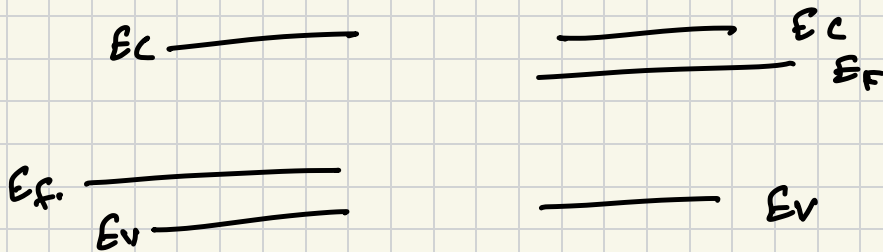
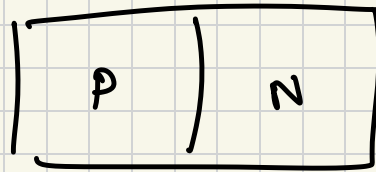


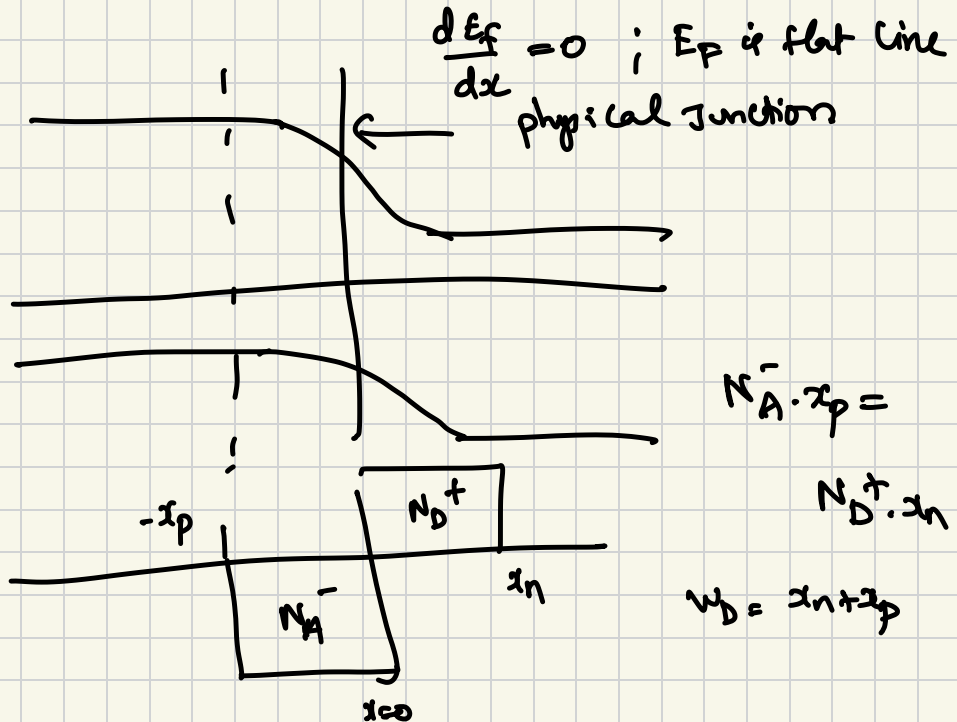


Principles of Semiconducting devices.

Let us make a Junction



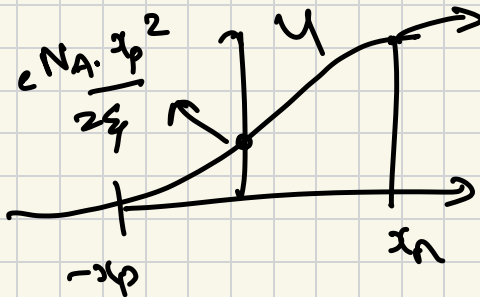
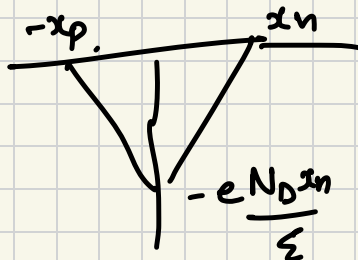
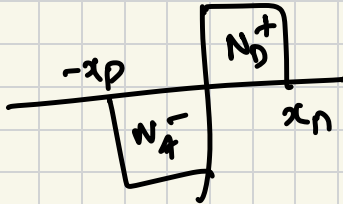
at equilibrium $\rightarrow$ no current



Poisson's equation

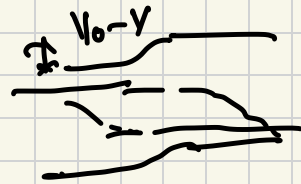
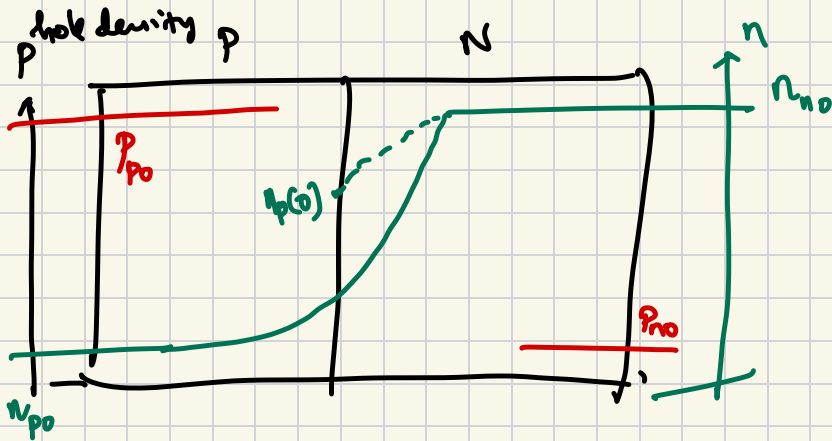
$$\frac{d^2v}{dx^2} = \rho/\epsilon$$

$$\xi = -\frac{dv}{dx}$$



$$V_{Bi} = \frac{e}{2\epsilon_f} \left[N_A x_p^2 + N_D x_n^2 \right]$$

A built-in voltage is obtained at the junction of p-n



Let us look only @ electrons:

$$- [E_C - E_F] / k_B T$$

$$n = N_C e$$

$$E_C \text{ in } p\text{-type is } E_C^p = E_C^n + V_0;$$

$$\therefore \frac{n_{p0}}{n_{n0}} = e^{-qV_0/k_B T}$$

When a bias V is applied the

$$E_C^p - E_C^n = V_0 - V;$$

$$\Rightarrow n_p(x) = n_n e^{-q[V_0 - V] / k_B T}$$

$$n_p(x) = n_{p0} \cdot e^{+qV / k_B T}$$

→ Law of Junction

$$\Delta n_p(x) = \Delta n_p(0) e^{-x/L_n} \quad \left[\Delta n_p(0) = n_p(0) - n_{p0} \right]$$

from the Fick's first law, the excess carrier will decay exponentially due to diffusion!

$L_n \rightarrow$ diffusion length.

diffusion current

$$\begin{aligned} J_n(x) &= e D_n \frac{d n_p(x)}{dx} \\ &= e D_n \cdot \frac{\Delta n_p(0)}{L_n} \cdot e^{-x/L_n} \\ &= \frac{e D_n}{L_n} [n_p(0) - n_{p0}] e^{-x/L_n} \end{aligned}$$

$$J_n(x) = \frac{e D_n}{L_n} n_{p0} \cdot e^{-x/L_n} [e^{qV} - 1]$$

current is the same everywhere; so calculating current at $x=0$

$$J_n = \frac{e D_n}{L_n} n_{p0} [e^{qV} - 1]$$

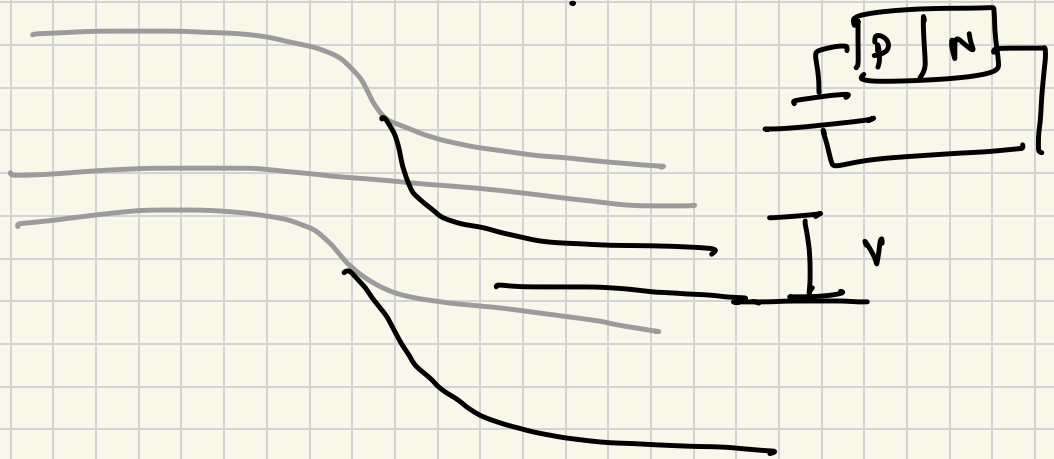
$$\text{Similarly } J_p = \frac{e D_p}{L_p} p_{n0} [e^{qV} - 1]$$

$$J = J_n + J_p = J_0 [e^{qV} - 1]$$

$$J_0 = \frac{e D_n}{L_n} n_{p0} + \frac{e D_p}{L_p} p_{n0}$$

— Shockley equation

Under reverse bias.



if N-side is lowered by applying a positive polarity