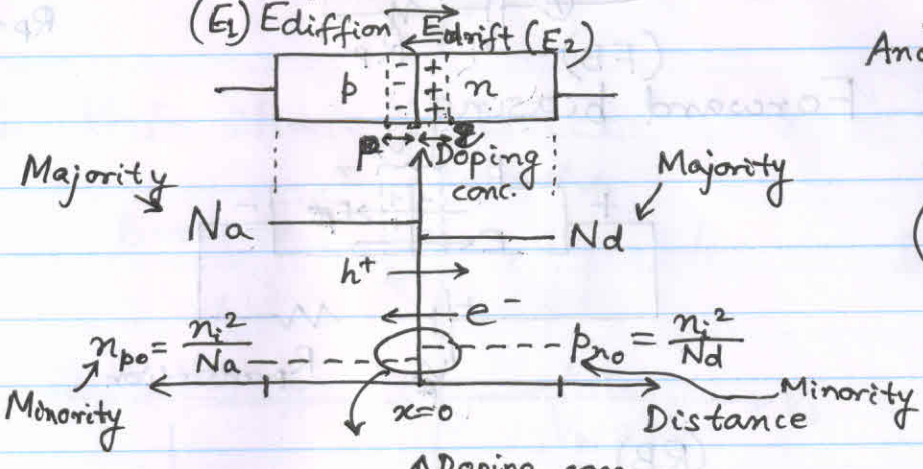
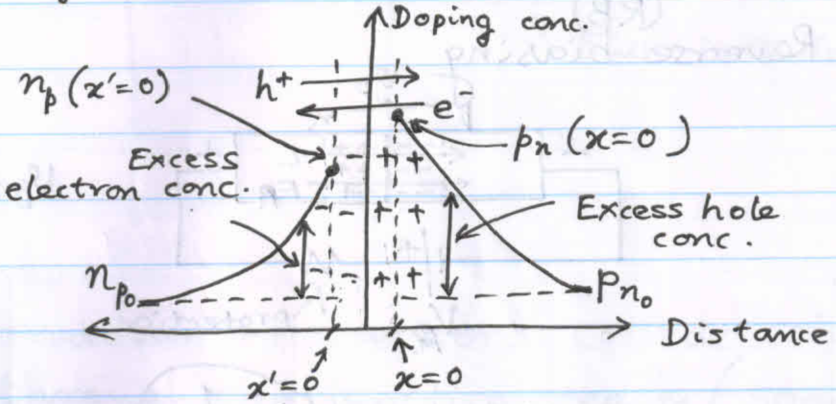
p-n Junction Diode

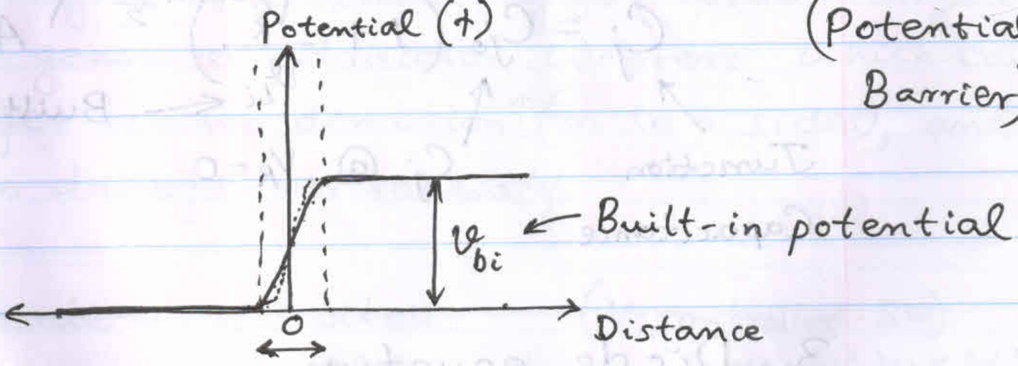
Symbol



(Majority & Minority Carriers)



(Minority Carriers)



(Potential Barrier)

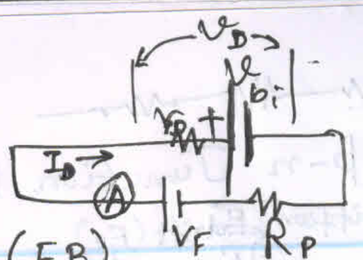
$$V_{bi} = \frac{kT}{q}\left(\frac{Na.Nd}{n_i^2}\right) \quad ; \text{ where, } \frac{kT}{q} = V_T$$

Thermal V

Application of V or I

Biasing of a p-n junction:

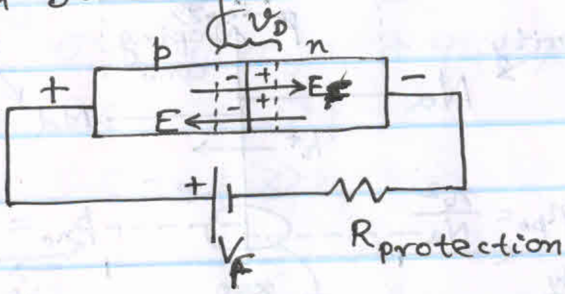
1) Forward biasing
2) Reverse biasing



$$I_D = \frac{V_F - v_{bi}}{R_P + r_D}$$

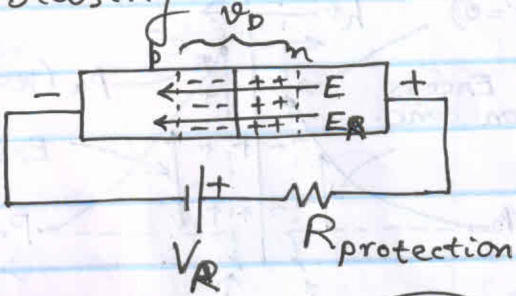
(FB)

1. Forward biasing



(RB)

2. Reverse biasing



$$v_D = V_R + \Delta V$$

$$C_j = C_{jo}\left(1 + \frac{V_R}{v_{bi}}\right)^{-\frac{1}{2}}$$

Applied V

Built-in potential

Junction Capacitance

C_j @ $V_R = 0$

3. Diode equation

$$i_D = I_S\left[e^{\frac{v_D}{nV_T}} - 1\right]$$

Diode Current

Reverse Bias Saturation Current

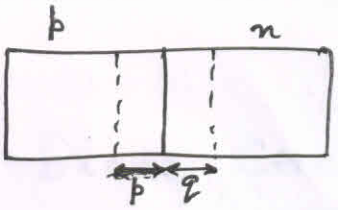
Emission Co-efficient or Ideality Factor

Thermal V $\left(\frac{kT}{q}\right)$

$V_T \cong 26$ mV @ 300K

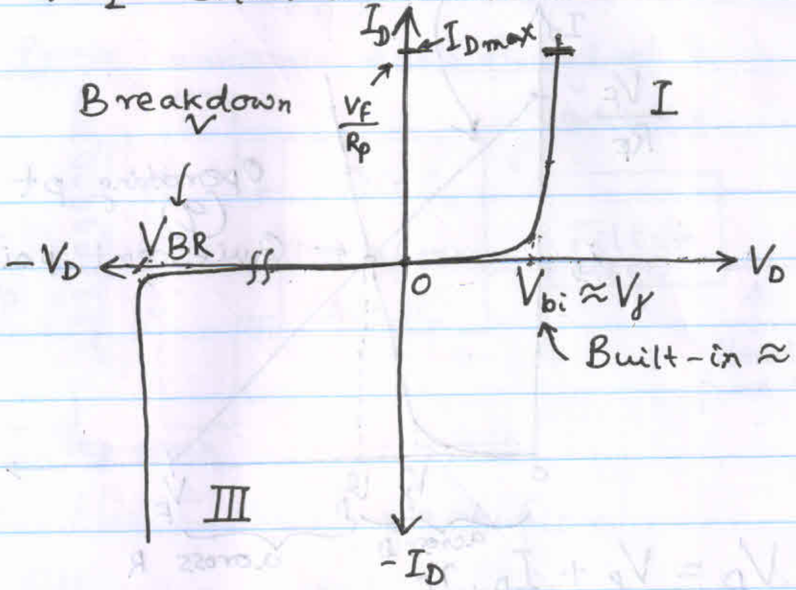
$n = 1$ to 2

$I_S = 10^{-15}$ to 10^{-13}



$p > q$

4. V-I characteristics



I : FB

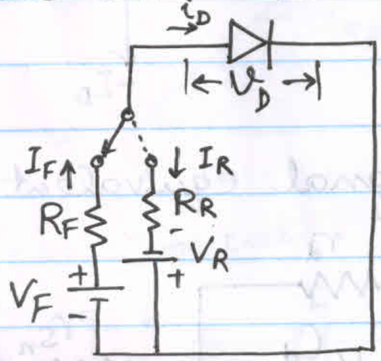
III : RB

Avalanche Break-dn

Breakdown → Carriers collide while passing through the junction region (space charge region) and generates additional carriers, which causes larger reverse direction I (n to p sides), and thus damages permanently.

5. Diode as a switch.

(V-controlled SW)

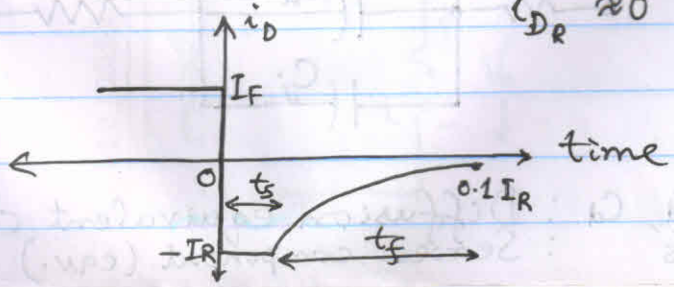


$i_{D_F} \approx 0$ (if $V_F \leq V_\gamma$)

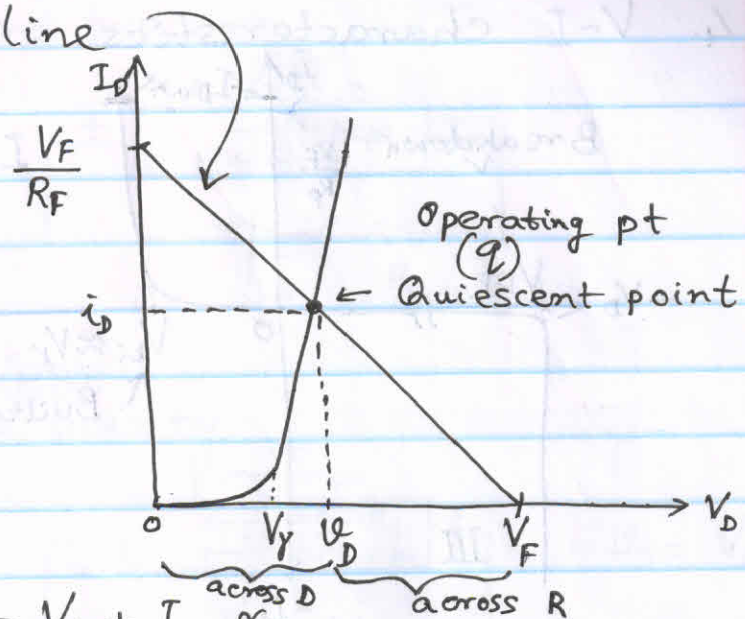
$i_{D_F} = I_F = \frac{V_F - V_D}{R_F}$ (if $V_F > V_\gamma$)

$i_{D_R} = -I_R = -\frac{V_R}{R_R}$ (at breakdown)

$i_{D_R} \approx 0$ (not at brk-dn)

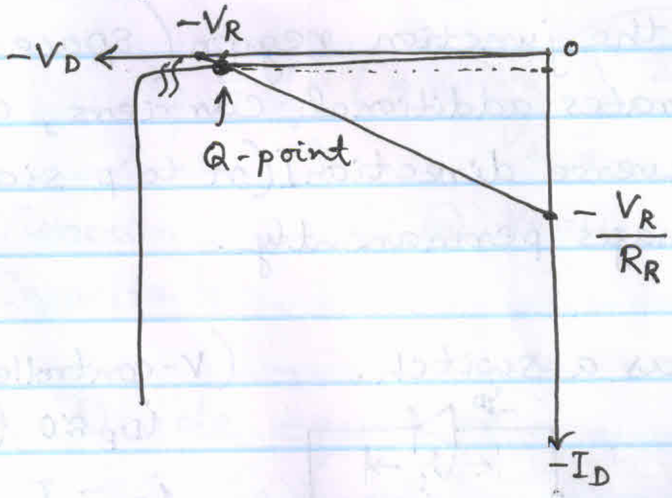


5. Load line

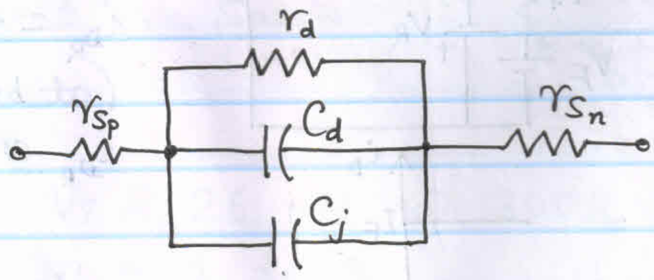


$$V_D = V_\gamma + I_D \cdot r_f$$

$$P_D = I_D \cdot V_D$$



6. Small signal equivalent ckt.



r_d, C_d : Diffusion equivalent components

r_s : Series component (eqv.)