Power Electronics :-

controlling and conversion of Electric power

→ Motor

→ AC ↔ DC

→ Batt. charger

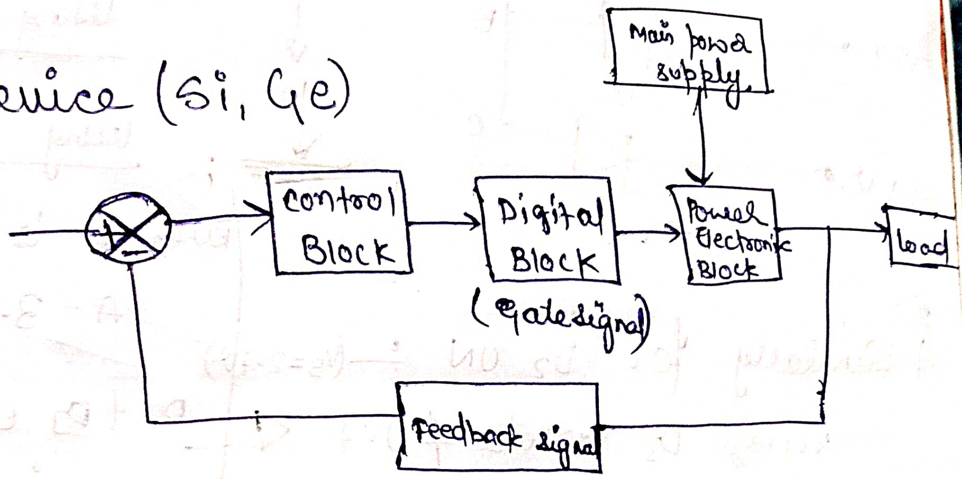
Uses semiconductor device (Si, Ge)

→ Diode

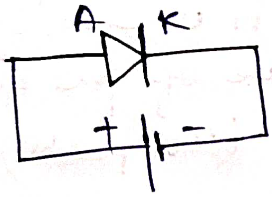
→ SCR | Thyristor

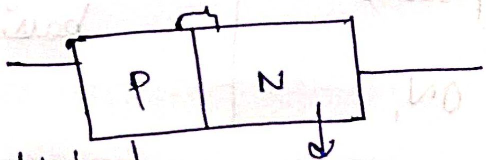
→ MOSFET

→ BJT



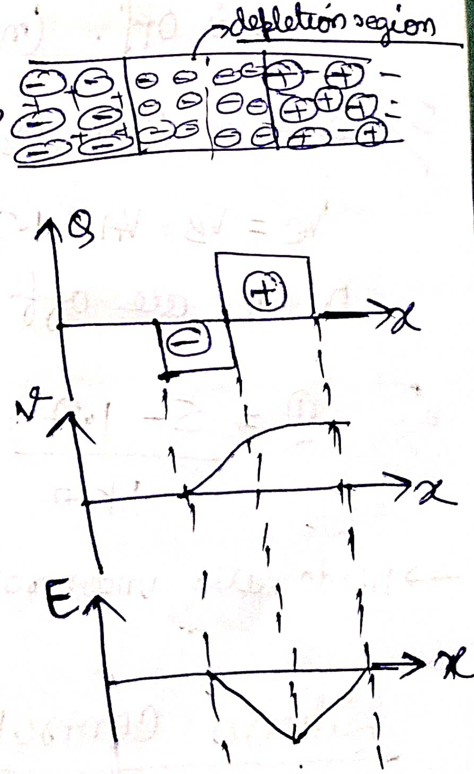
Diodes :-



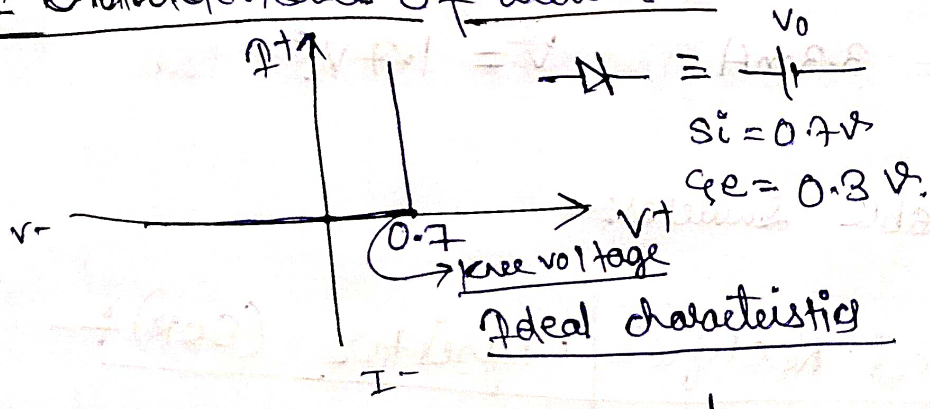


doping
→ BORON
→ Galium

doping
→ phosphorous
→ Arsenic

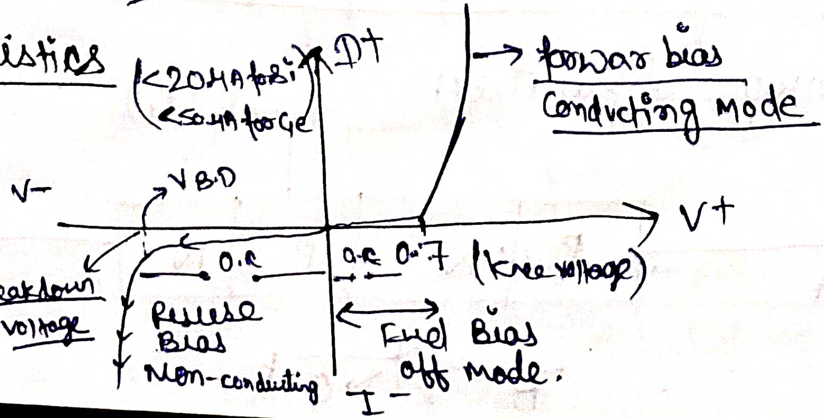


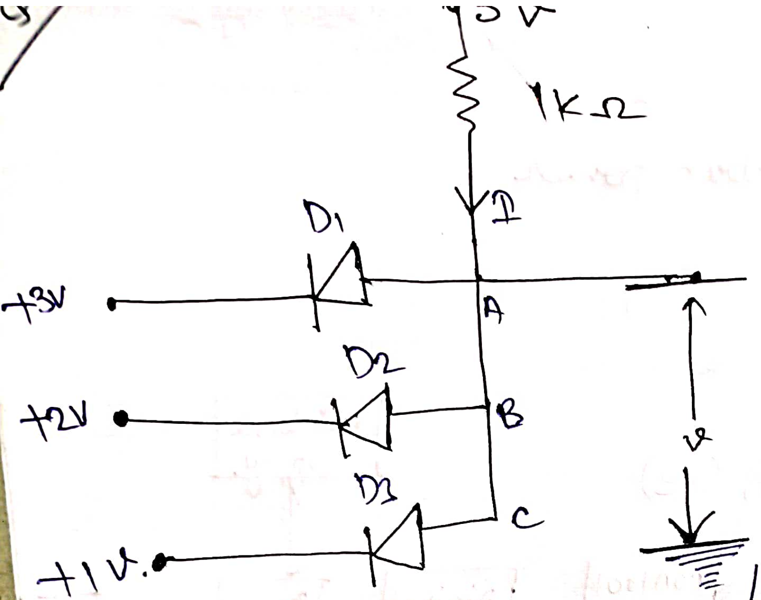
V-I characteristics of diode :-



Ideal characteristic

Actual characteristics





Find V & I ?

~~using O.C test~~

using S.C test

1) When D_1 is ON :-

$V_A = 3.7 = V_B = V_C = 3.7v.$

D_2 & D_3 ON & Voltage across them is 1.7 & 2.7 v which is not possible (as it is equal to 0.7 in case of fwd bias) (not possible)

2) * Similarly for D_2 ON :- ($V_B = 2.7v$)

voltage D_3 ~~violate~~ $\neq 0.7$

& D_1 is off. (not possible)

3) case III → When D_3 is ON,

$V_C = V_B = V_A = 1.7 v.$

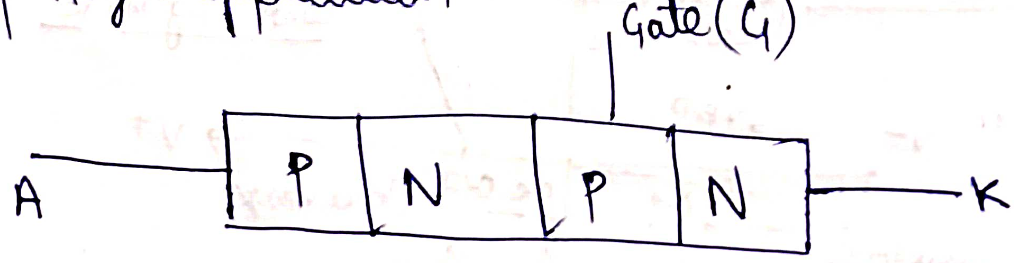
D_1 & D_2 are off (Possible case).

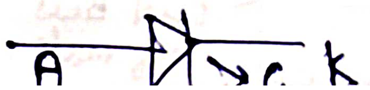
$$\therefore \quad I = \frac{5 - 1.7}{1k\Omega} = 3.3 mA. \qquad v = 1.7v.$$

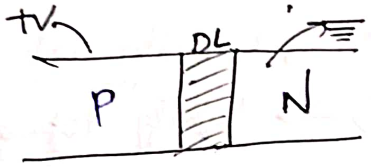
→ Diode are uncontrollable switches:-

Silicon controlled Rectifier | Thyristor (SCR) :-

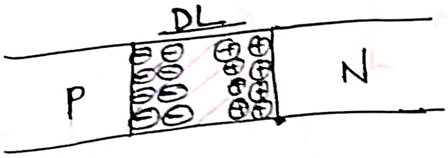
→ High current | voltage application



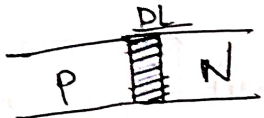




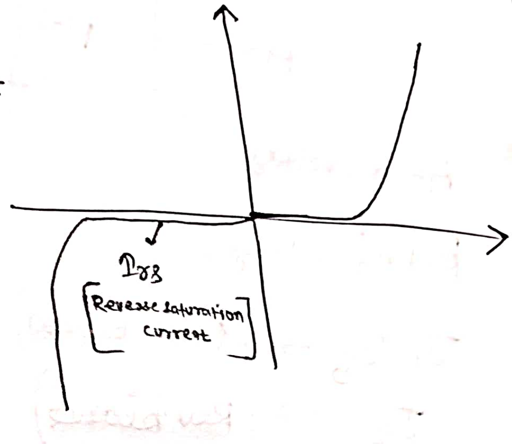
equilibrium
$V=0$



V-ve



V+ve



$I_F = I_{rs}\left(e^{\frac{qV_F}{\eta KT}} - 1\right)$

$\eta = 1$ (assume)

$\frac{KT}{q} = V_T =$ constant at a given temp. $= 26mV$.

$$\boxed{I_F = I_{rs}\left(e^{\frac{V_F}{V_T}} - 1\right)}$$

$$\frac{dI_F}{dV_F} = \frac{I_{rs}}{V_T} \times e^{\frac{V_F}{V_T}}$$

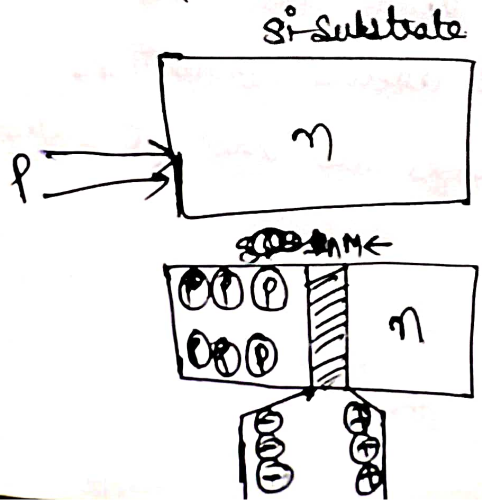
$$\frac{dV_F}{dI_F} = \frac{V_T e^{-\frac{V_F}{V_T}}}{I_{rs}} = r_{ac} \rightarrow \text{dynamic resistance}$$

I_{rs} depends on - Applied voltage (very little for $V > V_{BD}$)
↳ Temperature (strongly dependent).
↳ due to increase in free charge carriers (e^--holes pair formation)

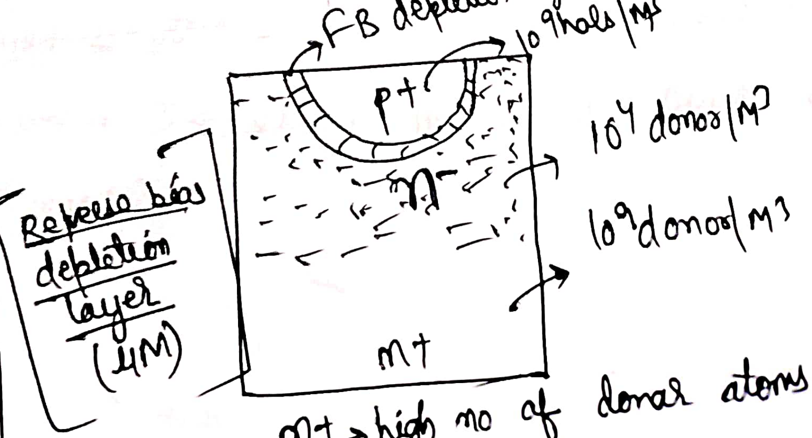
Q) A p-n junction diode has a reverse saturation current 50 nA at 32°. What I_F? If $V_F = 0.5V$ & assume $V_T = 26mV$.

Ans 11.24 A

low power diode



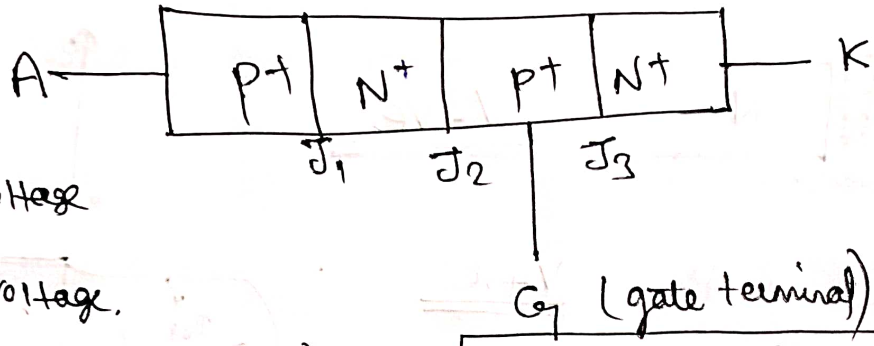
High Power diode



n+ → high no of donor atoms

SCR | Thyristor

⊕ → heavily doped.
⊖ → lightly doped.



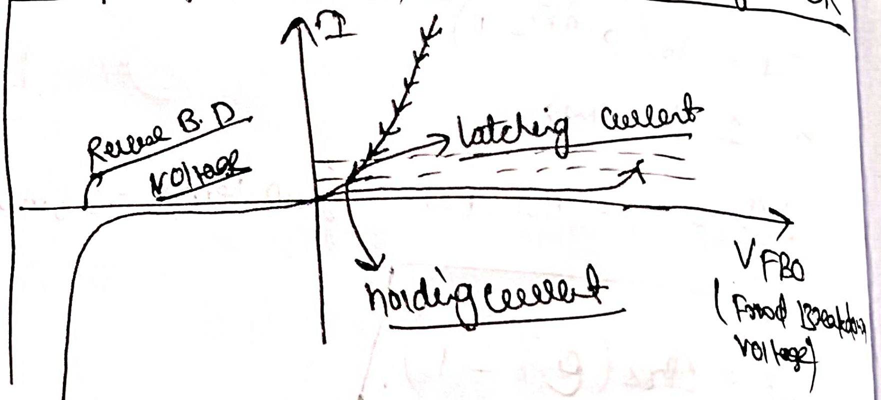
A(-ve) voltage

K(+ve) voltage.

J_1, J_3 → (Fwd biased)

J_2 → (Rev biased)

VI - Char of SCR



→ The latching current is minimum value of anode current which must be reached during turn on process to maintain conduction.

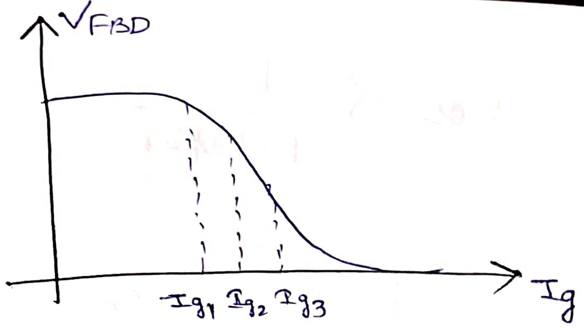
→ Holding current is the minimum value of ~~Holding~~ anode current below which if it falls the device will turn off.

Modes of SCR :-

1) Reverse blocking mode - J_1 J_3 Rev biased, J_2 is Fwd biased

2) Fwd " " - J_2 is Rev biased, J_1, J_3 are fwd biased.

3) Fwd conduction mode. - J_2 becomes very thin and allows conduction.
(Ig injects +ve charges into inner P-section)

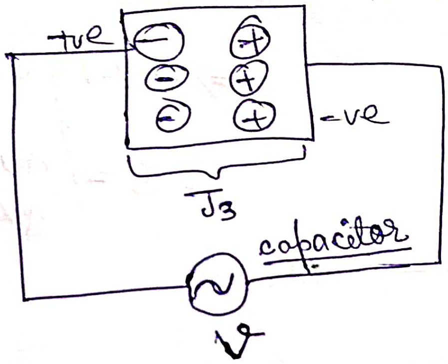


Different Methods of Turning on the SCR?

1> Voltage triggering (increase in input voltage).

2> Gate triggering (Applying $\underbrace{+ve\ I_g}_{+ve\ voltage\ pulse,}$ during FWD Bias case

3> $\frac{dv}{dt}$ triggering



Not a voluntarily choice SCR must be protected against this type of switching action.

$q = CV$

$I_A = C\frac{dv}{dt}$

$$\boxed{I_A \propto \frac{dv}{dt}}$$

4> Temperature triggering.

J_2 is heated up.

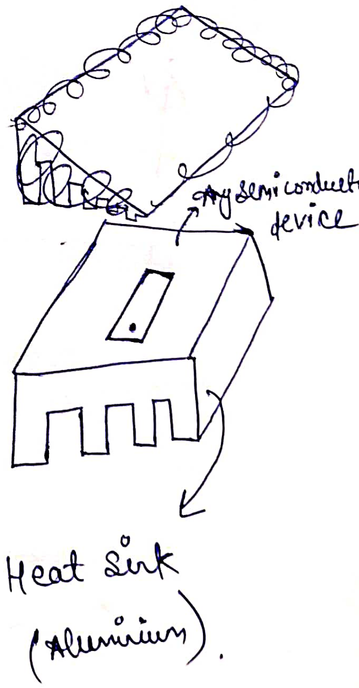
e^-/hole pair formation.

Flow of e^-/current ↑.

Heating of J_2

~~threshold~~ of

Thermal Runaway.



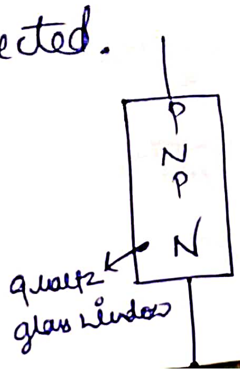
Temp triggering

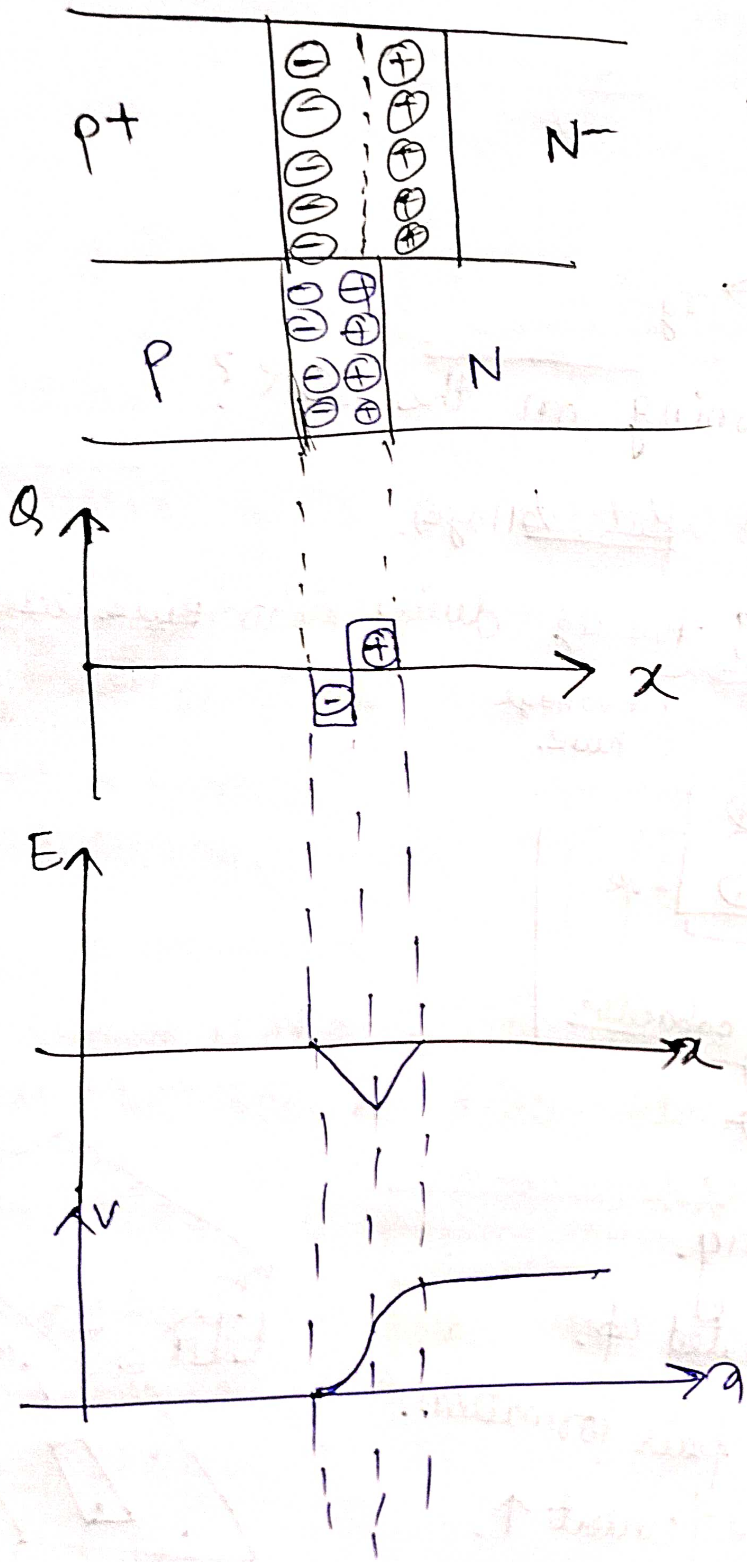
↳ Non voluntary.

↳ Device (SCR) must be protected.

5> Light triggering -

Light Activated SCR (LASCR).





$$W_{DL} \propto \frac{1}{\sqrt{N_{doping}}}$$

$$\nabla \cdot E = \rho_v$$

$$\frac{\bar{E}}{dv} = \rho_v .$$

$$\Rightarrow E(x) = \int \rho_v(x) + C.$$

$$-E = \frac{dv}{dx} , \quad \boxed{\frac{dE}{dx} = \frac{d^2 v}{dx^2}}$$