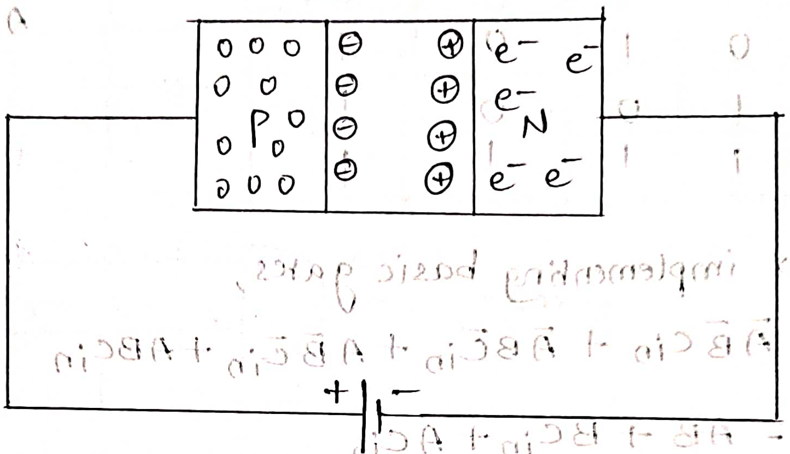
ASSIGNMENT - 1B

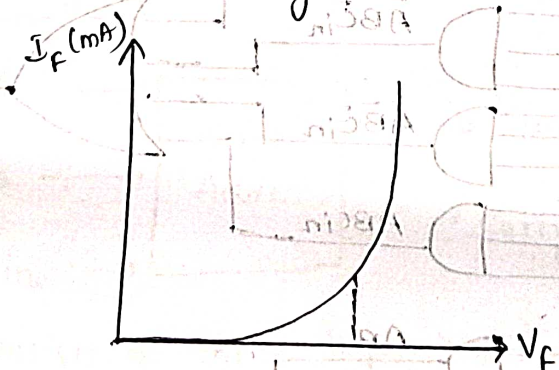
1) Explain forward and reverse bias of semiconductor diode with V-I characteristics.

→ * Forward bias

- PN junction said to be forward bias when the positive terminal of the battery is connected to P-type and negative terminal of the battery is connected to n-type as shown in the figure.



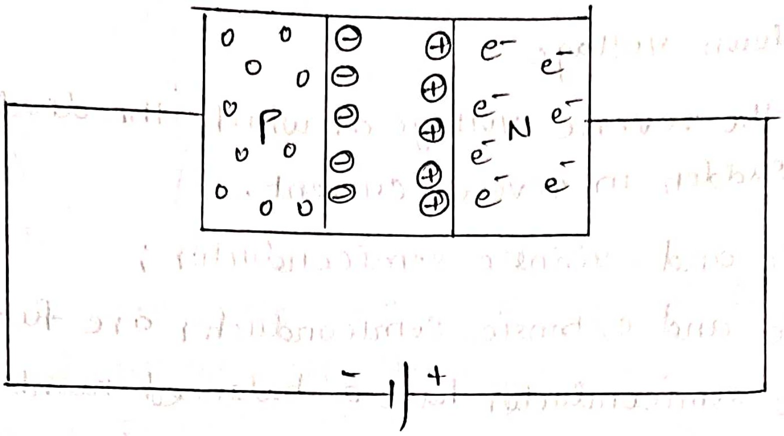
- If the applied voltage is less than the barrier potential there will be no conduction.
- When the applied voltage is more than the barrier potential then the holes on p-side which are positively charged gets repelled from positive terminal and driven towards junction.
- Similarly the electrons on n-side which are negatively charged gets repelled from negative terminal and move towards junction.



In case of forward bias the circuit will be act as a close and hence current is maximum and voltage is equal to zero.

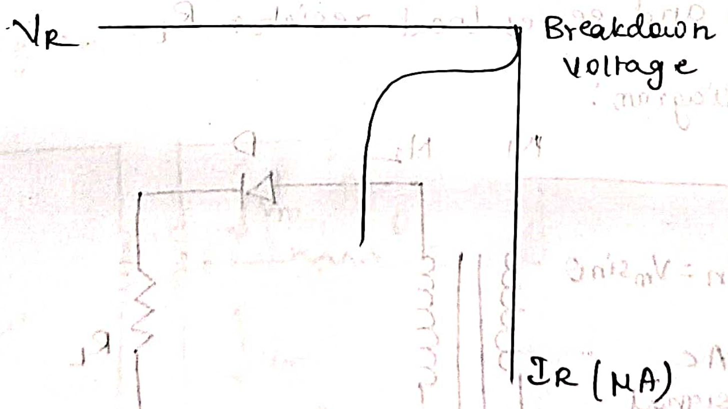
*reverse bias

- PN junction is said to reverse biased when the positive terminal of battery is connected to n-type & negative terminal of battery is connected to p-type.



- When p-n junction is reverse biased then the holes on p-side of junction acts attracted towards negative terminals and electrons on junction are attracted positive terminal of the battery.
- Thus holes on pside and electrons on n-side move away from the junction thereby increase the barrier potential.
- If the barrier voltage is increased, majority charged carrier cannot occurs the junction and there is no current flow across junction.
- Minority charge carriers cross the junction and leads to a small current flow called reverse current as shown in figure.

V-I characteristics:



In case of reverse ~~or~~ bias the circuit will be acts as open circuit hence current is equal to zero and voltage is equal to maximum.

2) Write a short note on

a) knee voltage:

→ It is the forward voltage at which the diode starts conducting.

b) Breakdown voltage

→ It is the reverse voltage at which the diode break down with sudden in reverse current.

c) intrinsic and extrinsic semiconductor;

Intrinsic and extrinsic semiconductor are fundamental. Intrinsic semiconductor have a balanced number of electrons and holes while extrinsic semiconductor have impurities semi-conductor can be either n-type or p-type.

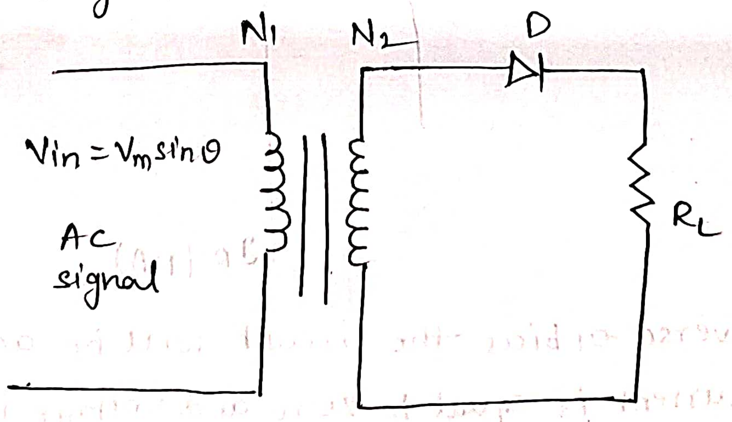
5 B) Explain with a neat circuit diagram and waveform,

a) Half wave rectifier.

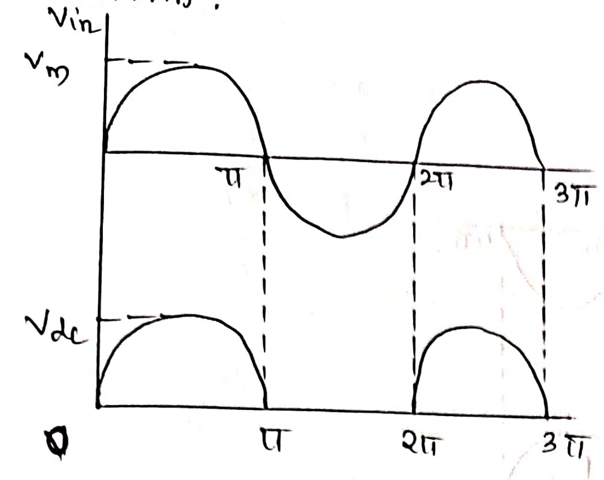
→ ∘ Rectifier which conducts current or voltage only during one half cycle of Ac input is called half wave rectifier.

- Figure shows full wave rectifier which single diode acts as half wave rectifier.
- AC input supply to be rectified is supplied through transformes to diodes and series load resistor R_L

Circuit diagram:



Waveform:



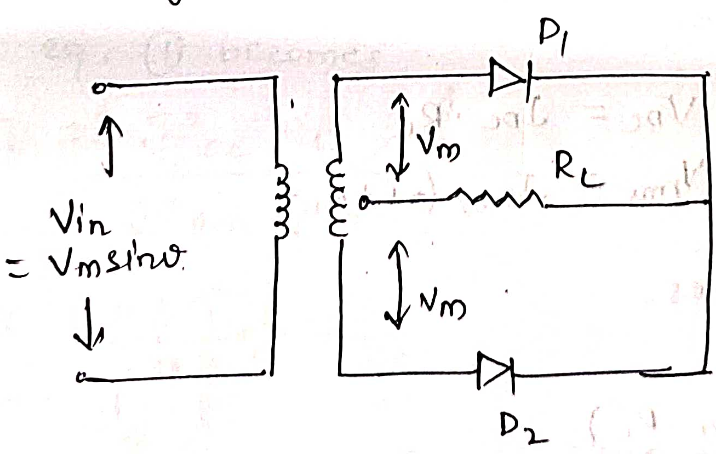
- During positive half cycle of supply voltage, diode is said to be forward baised acts as short circuit and current flown through R_L therefore $V_o = +V_{in}$

- During negative half cycle of supply diode is said to be reverse biased acts as open circuit and current do not flows through R_L therefore $V_o = 0$.

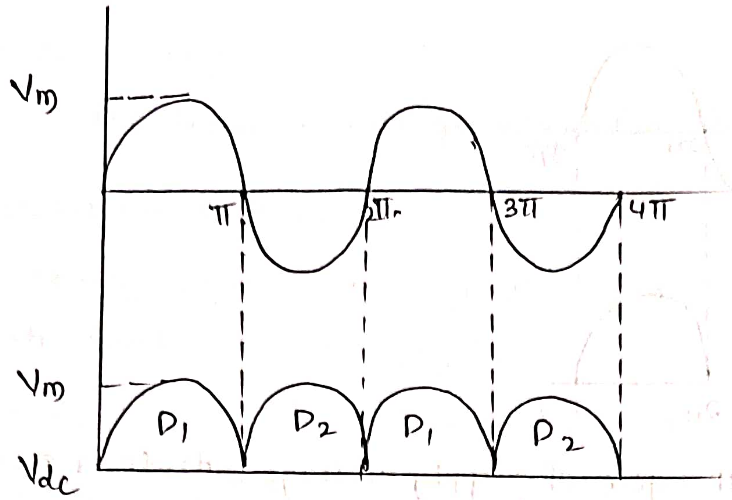
b) Full wave rectifier:

- Full wave rectifier converts both half cycle of AC input signal to pulsating dc.
- It consists of two diodes as shown in figure.
- Centre tapping in the secondary of the waveform is done to obtain two equal voltage but opposite phase.

Circuit diagram:



waveform :



- During positive half cycle, D1 is conducting and D2 is not conducting.
- During negative half cycle, D1 is non-conducting and D2 is conducting.
- In this way, a full wave rectifier converts both negative and positive half cycles of AC input to DC output.

6) Derive the expression of efficiency for :

a) Half wave rectifier ;

→ Efficiency ⇒ $\eta = \frac{\text{output power}}{\text{input power}} = \frac{P_{DC}}{P_{AC}}$

$$\eta = \frac{V_{DC} \cdot I_{DC}}{V_{rms} \cdot I_{rms}} \quad \text{—— (1)}$$

for HWR, let $V_{DC} = I_{DC} \cdot R_L$

$V_{rms} = I_{rms} (r_f + R_L)$

∴ eq. (1) becomes.

$$\eta = \frac{I_{DC} (I_{DC} \cdot R_L)}{I_{rms} (I_{rms} (r_f + R_L))}$$

$$\eta = \frac{I^2_{DC} R_L}{I^2_{rms}(R_L + r_F)}$$

$\because I_{DC} = \frac{I_m}{\pi}$

$I_{rms} = \frac{I_m}{2}$

$$\eta = \frac{I^2_{DC}}{I^2_{RMS}} \times \frac{R_L}{(R_L + r_F)} \rightarrow 1$$

$R_L >>> r_F$

$$\eta = \frac{\left(\frac{I_m}{\pi}\right)^2}{\left(\frac{I_m}{2}\right)^2} = \frac{\frac{I_m^2}{\pi^2}}{\frac{I_m^2}{2^2}} = \frac{4}{\pi^2}$$

$$\therefore \eta = \frac{4}{\pi^2} \times 100 = 0.405 \times 100 = 40.5$$

$$\boxed{\therefore \eta = 40.5\%}$$

b) Full wave rectifier (Centre tap)

→ Efficiency ⇒ $\eta = \frac{P_{output}}{P_{input}} = \frac{P_{DC}}{P_{AC}}$

$$\eta = \frac{V_{DC} \cdot I_{DC}}{V_{rms} \cdot I_{rms}} \quad \text{——} (1)$$

Let $V_{DC} = I_{DC} \times R_L$ $\quad V_{rms} = I_{rms} \times (r_F + R_L)$

$\therefore$ eq. (1) becomes $\quad \because R_L >>> R_F$

$$\eta = \frac{I^2_{DC} R_L}{I^2_{Rms}(R_L + r_F)} \rightarrow 1$$

$\because I_{DC} = \frac{2 I_m}{\pi}$

$I_{rms} = \frac{I_m}{\sqrt{2}}$

$$= \frac{2 I_m^2}{\pi^2} \times \frac{4}{I_m^2}$$

$$= \frac{8}{\pi^2} \times 100 = 0.8105 \times 100$$

$$\boxed{\therefore \eta = 81.05\%}$$

3) What do you understand by a semiconductor ? Discuss important properties of semi-conductor.

→ •) Semiconductors are materials that have the conductivity between a conductor and an insulator. The most popular semiconductors are silicon and germanium.

•) Semiconductors are of 2 types; Intrinsic & extrinsic semiconductors

i) Intrinsic semiconductors are pure semi-conductors. They will not have any impurities added to it while, extrinsic semiconductors are semiconductors with impurities.

* Properties of semi-conductors:-

1. The resistivity of semi-conductors lies between a conductor and an insulator.

2. Doping increases conductivity of semi-conductor.

3. They are formed by a covalent bonds.

4. At absolute zero temperature, it behaves as a perfect insulator.

5. At room temperature, it behaves as a conductor.

6. If we increase the temperature of semi-conductor, its electrical conductivity also increases.

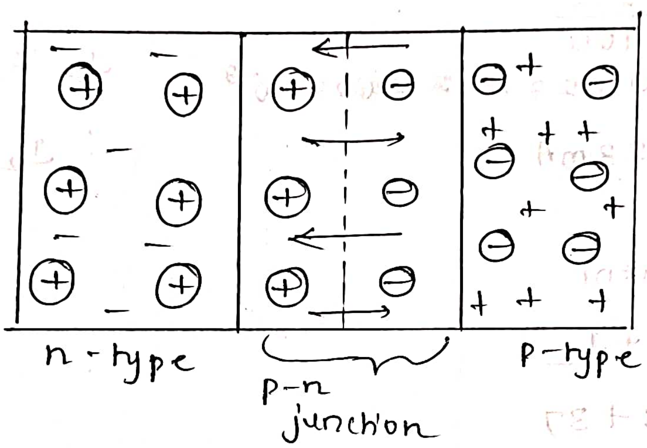
7. They have small energy gap (or) band gap.

4) What is a p-n junction ? Explain the formation of potential barrier in a p-n junction.

→ P-N junction;

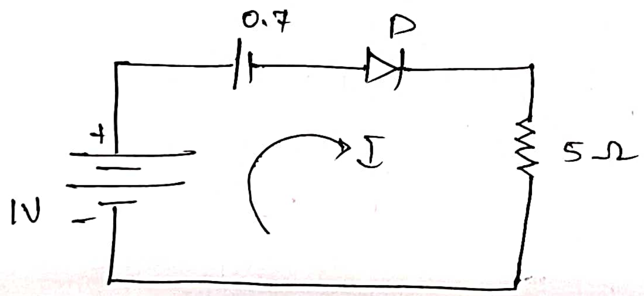
A p-n junction is an interface or a boundary between two semi-conductor material types, namely the p-type and the n-type, inside a semi-conductor.

- A p-n junction is formed by bringing p-type & n-type semi-conductors together in very close proximity.
- At the instant of p-n junction, movement of free electrons from the n-side and free holes from the p-side diffuse across the junction and combine and thus leave -ve ions on the p-side and +ve ions in n-side.
- These two layers of +ve & -ve ions form the depletion region and the potential difference thus sets up is called as potential barrier.



7) Find the current through the diode assume diode is silicon and forward resistance 0.

a)



$V_{in} - V_K - V_R = 0$ ∵ KVL law

$1 - 0.7 - IR = 0$

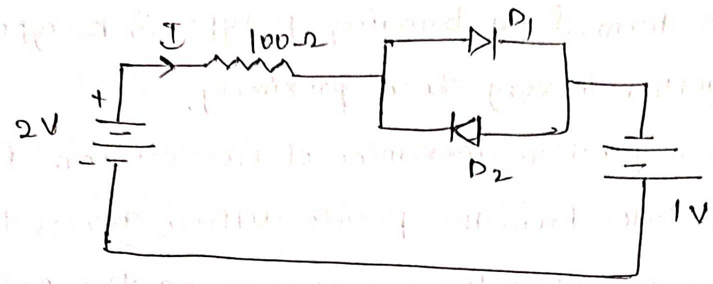
$1 - 0.7 - I \times R = 0$

$1 - 0.7 - I \times 5 = 0$

$I = \frac{1-0.7}{5} = \frac{0.3}{5} = 0.06A = 60 \times 10^{-3} A$

∴ $I = 60\,mA$

c)



$V_{in} - V_R - V_k + V_{in} = 0$ — ①

$2 - I_1 R - 0.7 + 1 = 0$

$2 - I_1(100) + 0.3$

$I_1(100) = 0.3 - 2$

$I_1 = \frac{2.3}{100}$

$I_1 = 0.023\ A = 23 \times 10^{-3}$

$I_1 = 23\ mA$

$V_{in} - V_R - V_K + V_{in}$ — ②

$2 - I_2 R + 0.7 + 1$

$2 - I_2(100) + 1.7$

$I_2 = \frac{3.7}{100}$

$I_2 = 0.037\ A = 37 \times 10^{-3}$

$\therefore I_2 = 37\ mA$

$\therefore$ current

$I = I_1 + I_2$

$= 23 + 37$

$\boxed{I = 60 mA}$