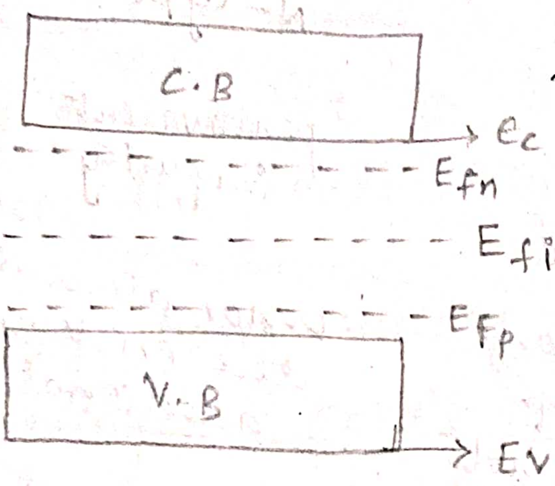
24/09/25

★ Energy band diagram :- The energy band diagram has two axes. the vertical axes shows the energy of the electron, while the horizontal axes represents the position of the electron, which corresponds to the energy band. $E_{Fi} = \frac{E_c + E_v}{2}$



Here,

E_c = Bottom of the conductor band
E_V = Top of the valence band
E_{Fi} = Fermi energy
E_{FP} = Fermi energy for ptypes
E_{Fn} = Fermi energy for N-type

The fermi energy level in a semiconductor is given by ;

$$f(E) = \frac{1}{1 + \exp\left[\frac{E - E_F}{kT}\right]}$$

where, E = energy
E_F = fermi energy
K = Bol.
T = Temperature

* PN Junction Diode

A PN junction diode is a semiconductor device which can be design ~~but~~ or fabricated by suitable sandwich of Pand N-Type semiconductor material.

Explain construction principle of PN Junction Diode

construction

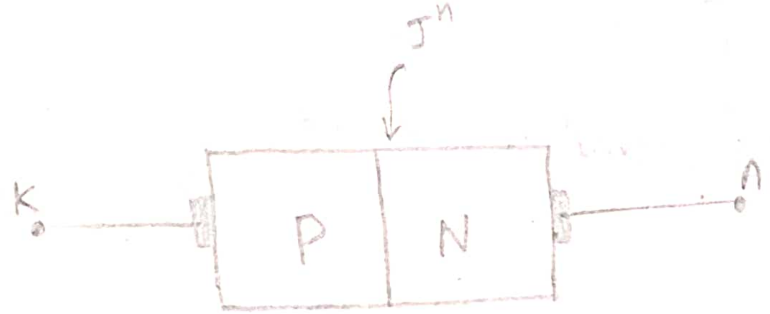


fig :- construction of PN Junction Diode

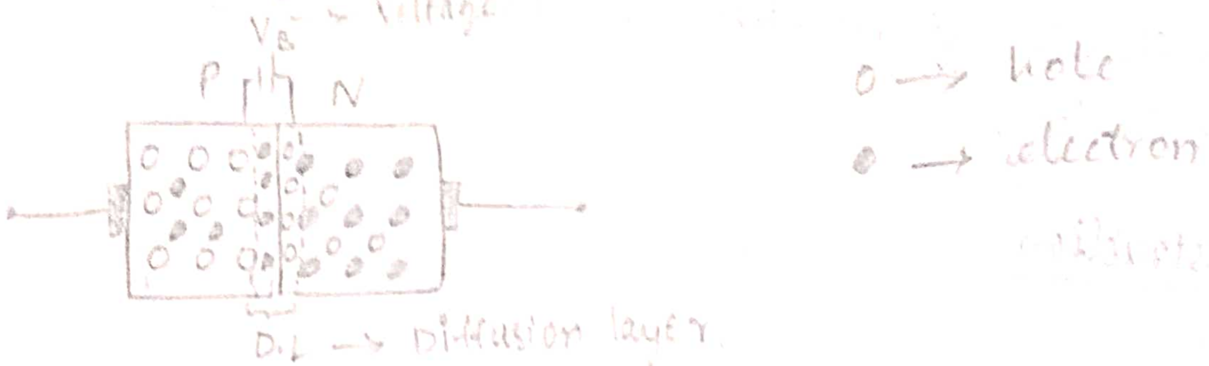
Ckt symbol :-

* working of PN Junction Diode

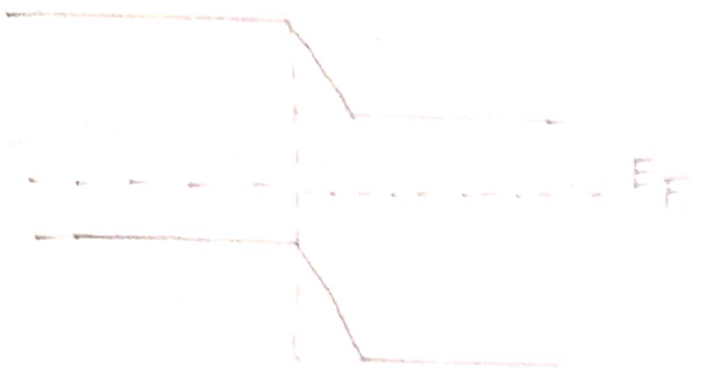
The working principle of semiconductor diode can be explain into three ways

1. Zero bias
2. Forward bias
3. Reverse bias

~~Zero~~ Zero bias :- when no voltage have been applied in a semiconductor diode then such types of biasing is known as zero bias.



PN junction is Asymmetric device

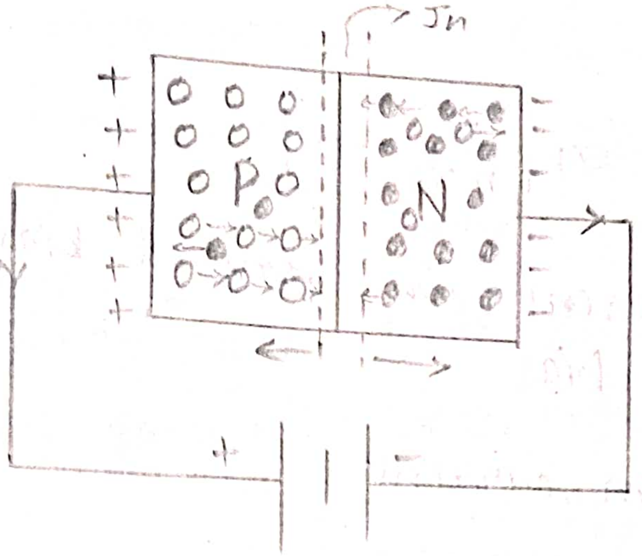


29/09/23

★ Forward bias :-

~~A semiconductor~~

when p-type terminal of PN junction diode is connected to positive terminal of supply voltage that is battery where as, ~~an~~ N-type terminal of PN junction diode is connected to negative of the power supply voltage then such type of arrangement is called forward biased PN junction. as is shown by below

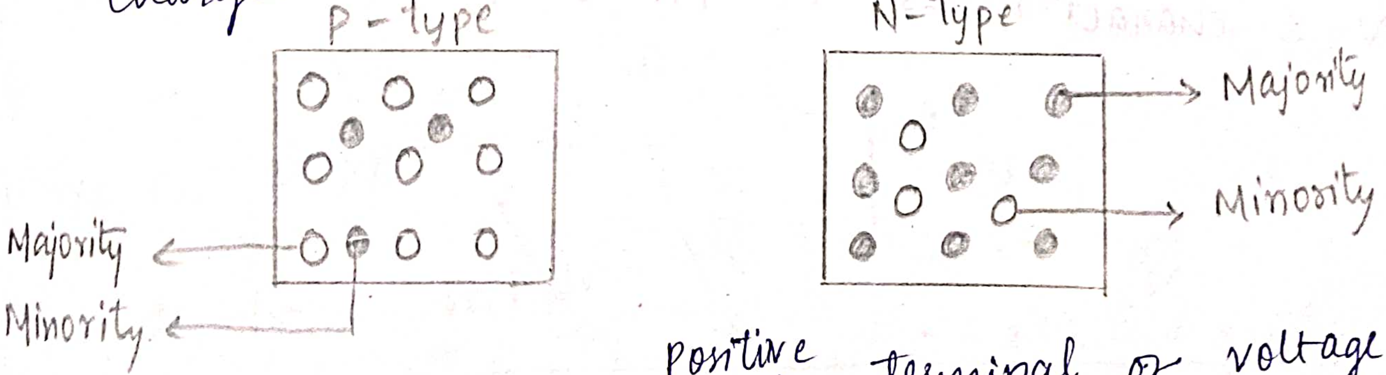


$I = I_e + I_h$

* Reverse ~~Bias~~ :-

working principle :-

we know that in P-type semiconductor the holes ~~charge~~ are in majority charged carrier and electron are in minority charged carrier, where as in N-type semiconductor the electrons are in majority charged carrier and holes are in minority charged carrier as shown in below figure.



when we apply the ~~passing~~ positive terminal of voltage to the P-type terminal of the PN junction diode and strong positive electric will created P-type terminal. Similary the negative terminal of voltage to the N-type terminal to the PN junction diode and strong negative electric will be created N-type terminal.

04/10/23

Diode Eq^n :-

$$I_D = I_s \quad \exp\left[\frac{V}{\eta V_T} - 1\right]$$

where,

I_D = Diode current in forward bias (or) reverse bias

I_s = saturation current

V_T = volt equivalent temperature

Forward bias :-

$V \rightarrow +V_f$

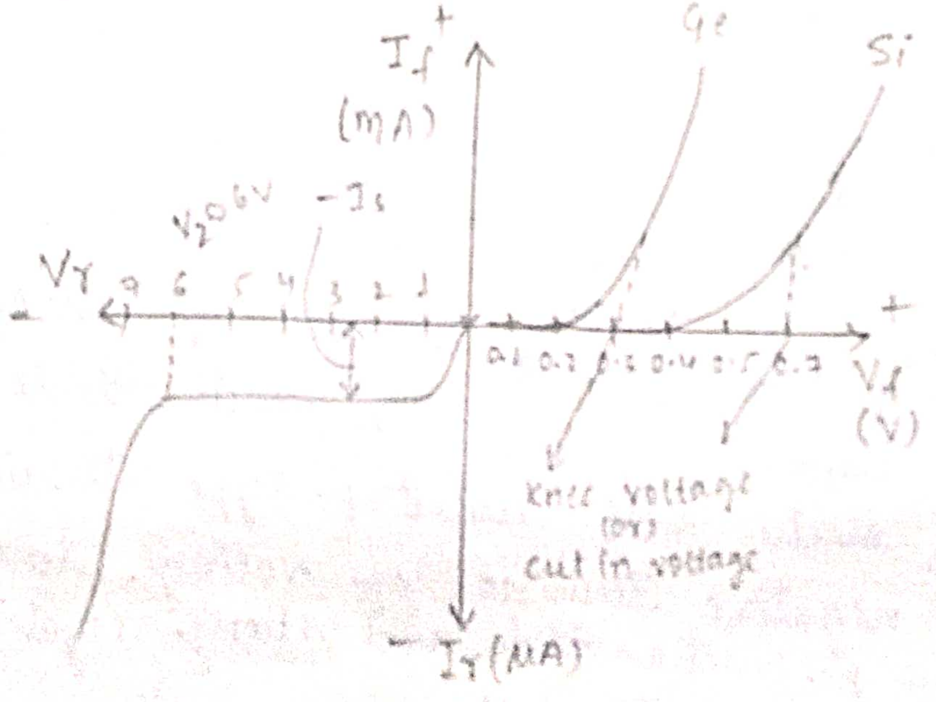
$$I_D \approx I_s \quad \exp\left(\frac{V_f}{\eta V_T}\right)$$

Reverse bias :-

$V \longrightarrow -V_r$

$$I_D \approx -I_s$$

V-I characteristics of PN J^n :-



Breakdown

- Avalanche
- Zener

There are two types of diode resistance that can be measured in forward bias only

Diode Resistance (R_D)

- Static
- Dynamic

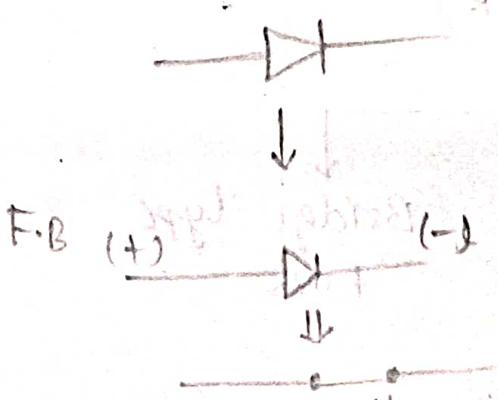
$$R_D = \frac{V_D}{I_D}$$

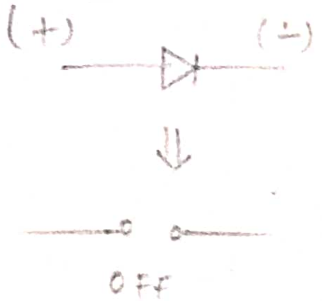
$$r_d = \frac{\Delta V_d}{\Delta i_d}$$

★ Application of semiconductors diode

1. As a switch
2. As a Rectifier
3. As a clipper
4. As a clapper

→ Diode in a switch





(universal diode)

→ **Rectifier**

The process of converting alternating current (or) voltage that is AC voltage to DC voltage is known as rectification and the circuit used for this is called Rectifier.

AC — AC : Transformation

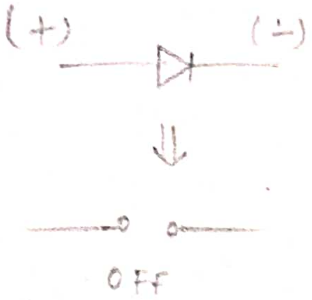
AC — DC : Rectifier

DC — AC : Inverter (oscillator)

DC — DC : chopper

On the basis of converting AC to DC voltage we can classify the rectifier as

Types
- Half wave Rectifier (HWR)
- Full wave Rectifier (FWR)
  - Centre tapped FWR
  - Bridge type FWR



(universal diode)

→ **Rectifier**

The process of converting alternating current (or) voltage that is AC voltage to DC voltage is known as rectification and the circuit used for this is called Rectifier.

AC — AC : Transformation

AC — DC : Rectifier

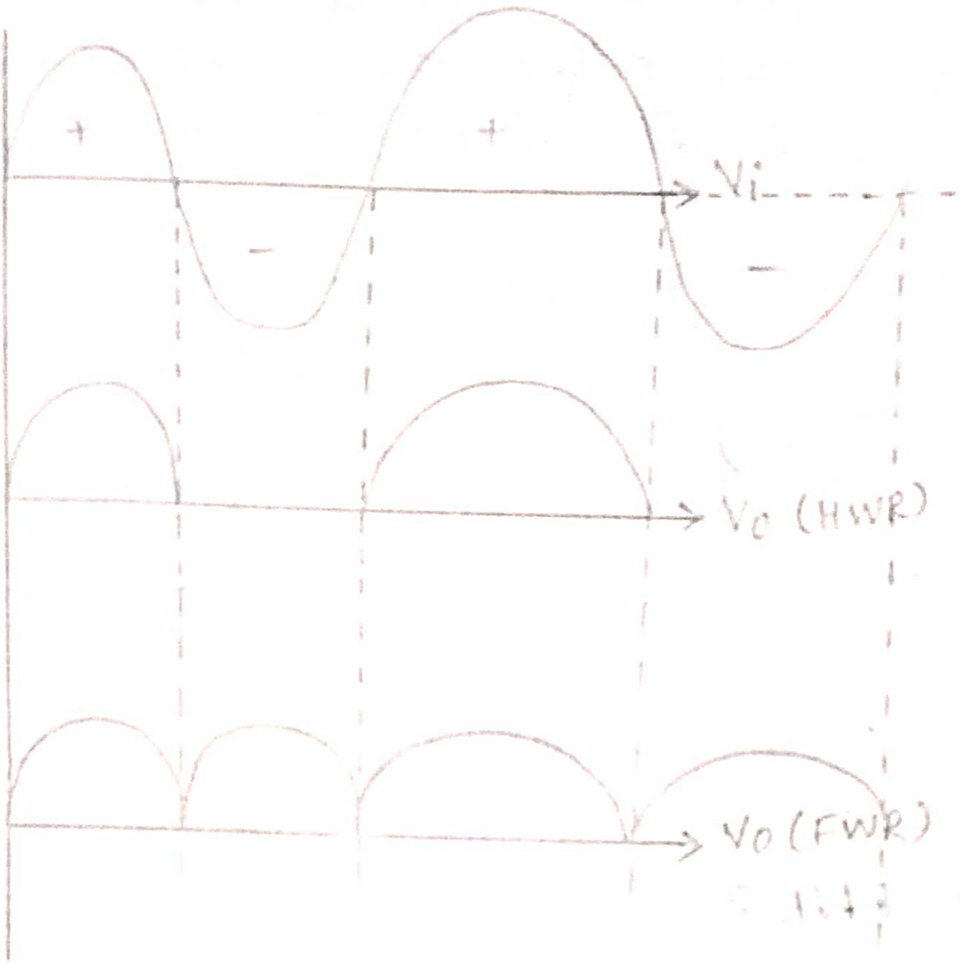
DC — AC : Inverter (oscillator)

DC — DC : chopper

On the basis of converting AC to DC voltage we can classify the rectifier as

Types

- Half wave Rectifier (HWR)
- Full wave Rectifier (FWR)
  - Centre tapped FWR
  - Bridge type FWR



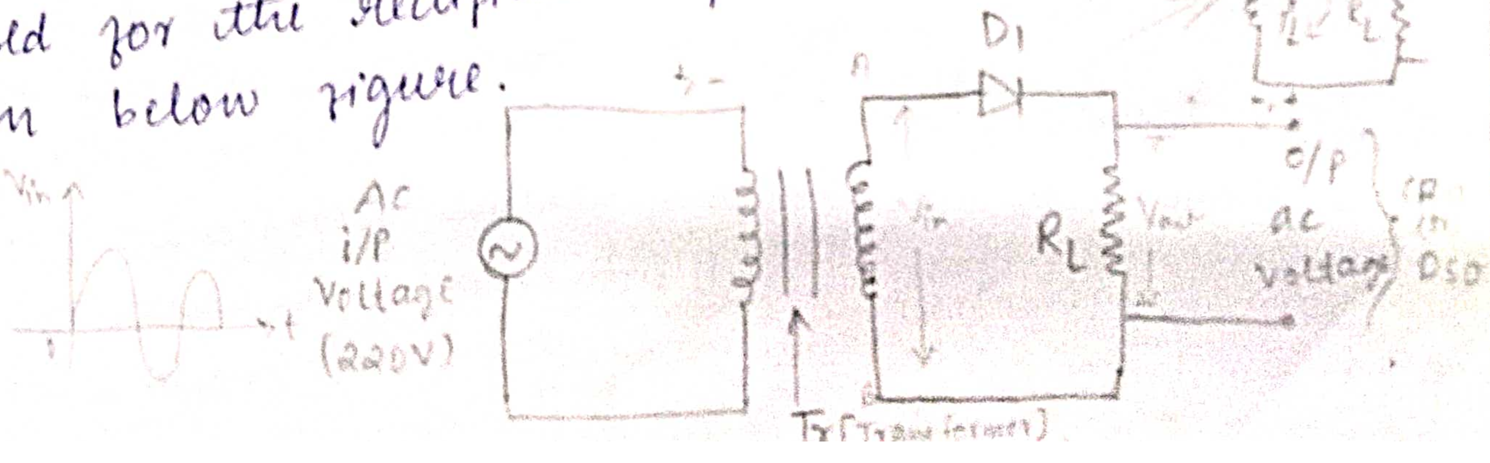
06/10/23

★ Half wave Rectifier (HWR)

In half wave Rectifier the only the half of the input signal is rectifier to the output so it is called Half wave rectifier.

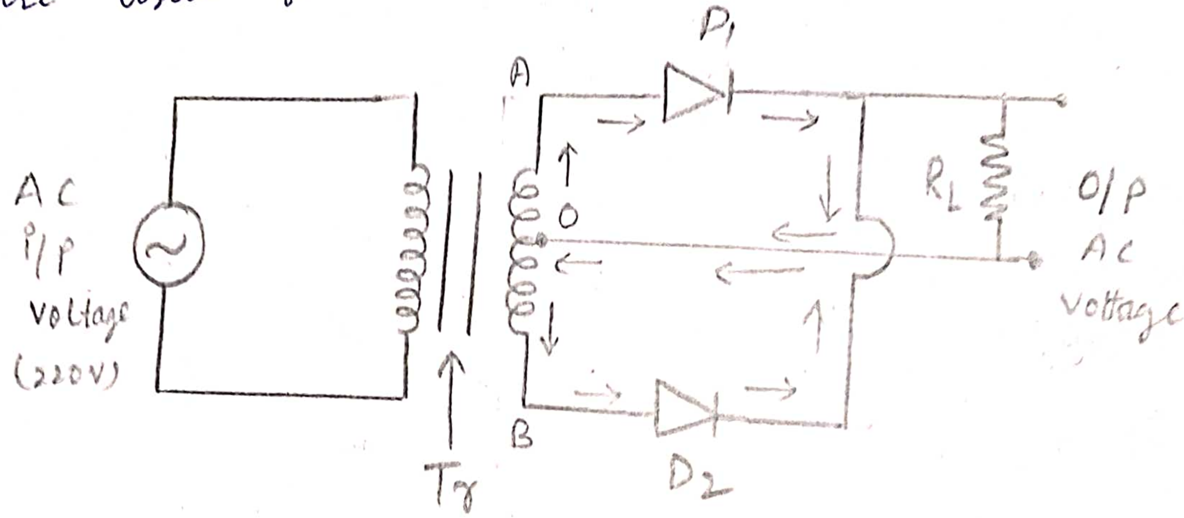
circuit diagram;-

In half wave rectifier circuit only 1 diode is used for the rectification process as shown in below figure.



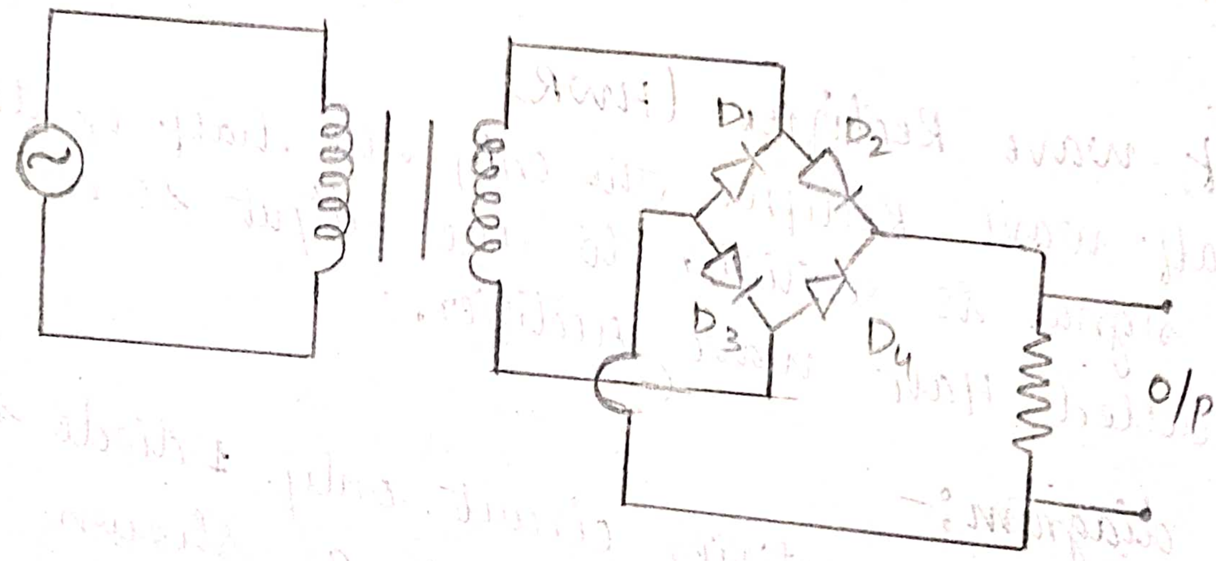
Circuit digram of FRWR :-

In the case of FWR both are of the input-pulse will rectify at the output and hence, 2 diodes are used for this as shown in below figure,



Center tapped FWR

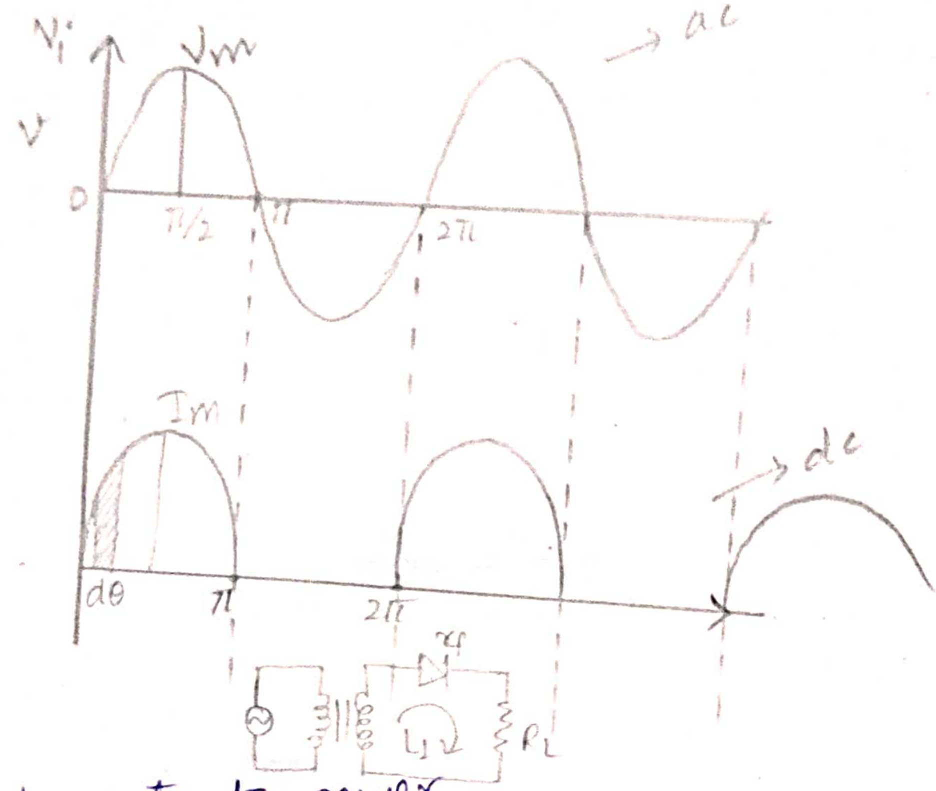
☆ Bridge type FWR :-



11/10/23

★ Efficiency and rectifier of half-wave Rectifier :-

The efficiency of HWR is defined as the ratio of D.C output power to the A.C input power



i.e, $\eta = \dfrac{\text{dc output power}}{\text{ac input power}}$

let $v = V_m \sin \omega t$; $\theta = \omega t$ ——— ①

& R_f and R_L is the diode resistance and load resistance. the diode conducts only during positive half-cycle of ac supply, ~~Hence~~

Hence,

$$\left.\begin{aligned} i_L &= I_m \sin\theta , & 0 \le \theta \le \pi \\ &= 0 , & \pi \le \theta \le 2\pi \end{aligned}\right\} \text{——— ②}$$

where, I_m = amplitude of or peak voltage or diode current.

If V_m is the maximum amplitude of the secondary voltage.

$$I_m = \frac{V_m}{r_f + R_L} \quad \text{——— (3)}$$

since, the output current is pulsating D.C.
Hence, to find dc power, average current has to be find out.

- DC Power :-

$$I_{av} = I_{dc} = \frac{\text{Area under cover in a cycle}}{\text{Base}}$$

$$= \frac{\int_0^{\pi} i \, d\theta}{2\pi} = \frac{1}{2\pi} \int \frac{V_m \sin\theta}{r_f + R_L} \cdot d\theta$$

$$= \frac{V_m}{2\pi(r_f + R_L)} \cdot \int_0^{2\pi} \sin\theta \, d\theta$$

$$= \frac{V_m}{2\pi(r_f + R_L)} \left[-\cos\theta\right]_0^{2\pi} \quad \therefore = 2$$

$$I_{dc} = \frac{V_m}{\pi(r_f + R_L)}$$

$$I_{dc} = I_{av} = \frac{I_m}{\pi}$$

the output power dc will be ;

$$P_{dc} = I_{dc}^2 \cdot R_L$$

$$= \left(\frac{I_m}{\pi}\right)^2 \times R_L \quad \text{——— (4)}$$

11/1 • AC input power :-

☆ $$P_{ac} = I_{rms}^2 (r_f + R_L)$$

$$P_{ac} = \left(\frac{I_m}{2}\right)^2 \times (r_f + R_L) \quad \text{—— (5)}$$

For HWR, $I_{rms} = \frac{I_m}{2}$

Hence, the efficiency of HWR will be,

$$\eta = \frac{P_{dc}}{P_{ac}}$$

$$= \frac{\left(\frac{I_m}{\pi}\right)^2 \times R_L}{\left(\frac{I_m}{2}\right)^2 \times (r_f + R_L)}$$

$$= \frac{\frac{4}{\pi^2}}{(r_f + R_L)} \times R_L$$

$$\boxed{\eta = \frac{0.406}{(r_f + R_L)} \times R_L}$$

(or)

$$\boxed{\eta = \frac{0.406}{1 + \frac{r_f}{R_L}}} \quad \text{—— (6)}$$

As we know that this $r_f << R_L$ that why $\frac{r_f}{R_L} <<<$

$$\eta = 0.406$$

$$\boxed{\% \eta = 40.6 \%}$$

This shows that in HWR a maximum of 40.6% of ac power is converted into dc output power.